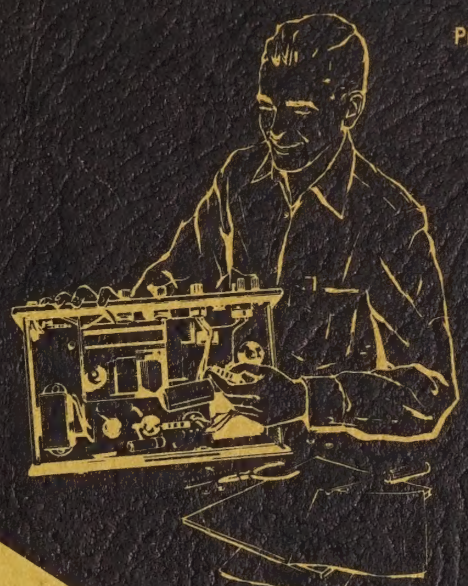
H. Oscilloscope OM-3

PRICE $2.00



Assembling and Using Your...

Heathkit

OSCILLOSCOPE

MODEL OM-3

HEATH COMPANY

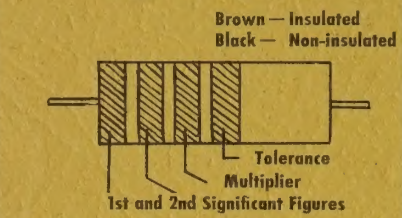
A Subsidiary of Daystrom Inc.

BENTON HARBOR, MICHIGAN

595-185

STANDARD COLOR CODE — RESISTORS AND CAPACITORS

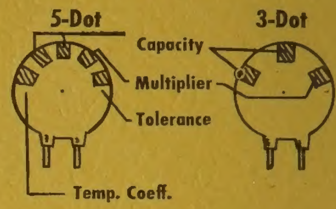
AXIAL LEAD RESISTOR



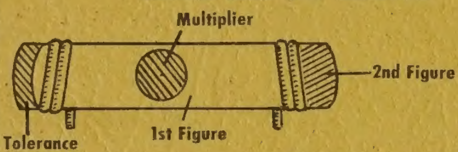
Wire wound resistors have
1st digit band double width

INSULATED UNINSULATED Color	FIRST RING BODY COLOR First Figure	SECOND RING END COLOR Second Figure	THIRD RING DOT COLOR Multiplier
BLACK	0	0	None
BROWN	1	1	0
RED	2	2	00
ORANGE	3	3	,000
YELLOW	4	4	0,000
GREEN	5	5	00,000
BLUE	6	6	000,000
VIOLET	7	7	0,000,000
GRAY	8	8	00,000,000
WHITE	9	9	000,000,000

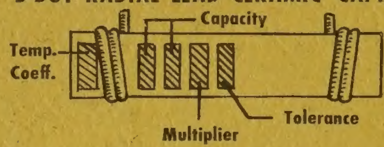
DISC CERAMIC RMA CODE



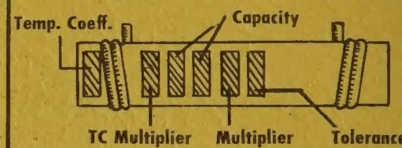
RADIAL LEAD DOT RESISTOR



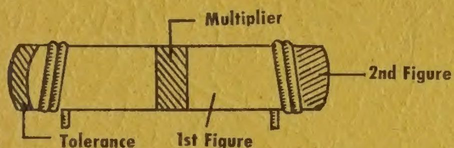
5-DOT RADIAL LEAD CERAMIC CAPACITOR



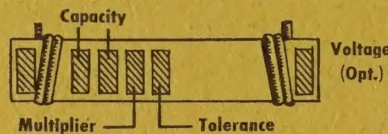
EXTENDED RANGE TC CERAMIC HICAP



RADIAL LEAD (BAND) RESISTOR



BY-PASS COUPLING CERAMIC CAPACITOR



AXIAL LEAD CERAMIC CAPACITOR

The standard color code provides all necessary information required to properly identify color coded resistors and capacitors. Refer to the color code for numerical values and the zeroes or multipliers assigned to the colors used. A fourth color band on resistors determines tolerance rating as follows: Gold = 5%, silver = 10%. Absence of the fourth band indicates a 20% tolerance rating.

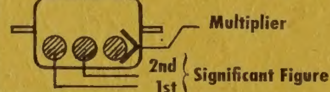
The physical size of carbon resistors is determined by their wattage rating. Carbon resistors most commonly used in Heathkits are ½ watt. Higher wattage rated resistors when specified are progressively larger in physical size. Small wire wound resistors ½ watt, 1 or 2 watt may be color coded but the first band will be double width.

MOLDED MICA TYPE CAPACITORS

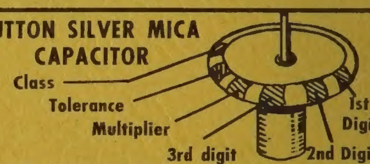
CURRENT STANDARD CODE

JAN & 1948 RMA CODE

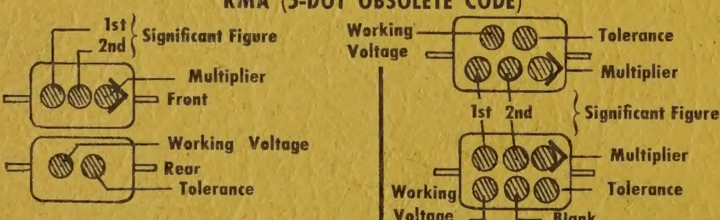
RMA 3-DOT (OBSOLETE) RATED 500 W.V.D.C. ± 20% TOL.



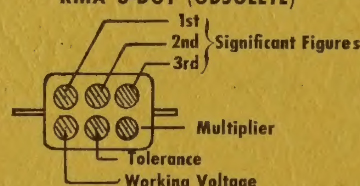
BUTTON SILVER MICA CAPACITOR



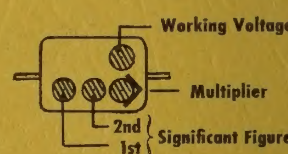
RMA (5-DOT OBSOLETE CODE)



RMA 6-DOT (OBSOLETE)

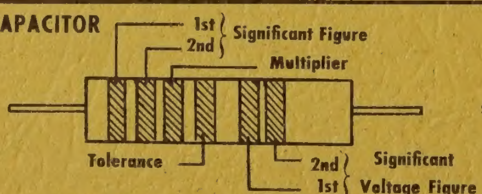


RMA 4-DOT (OBSOLETE)



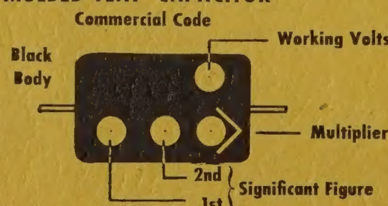
MOLDED PAPER TYPE CAPACITORS

TUBULAR CAPACITOR

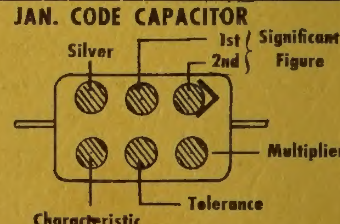


A 2 digit voltage rating indicates more than 900 V.
Add 2 zeros to end of 2 digit number.

MOLDED FLAT CAPACITOR



JAN. CODE CAPACITOR



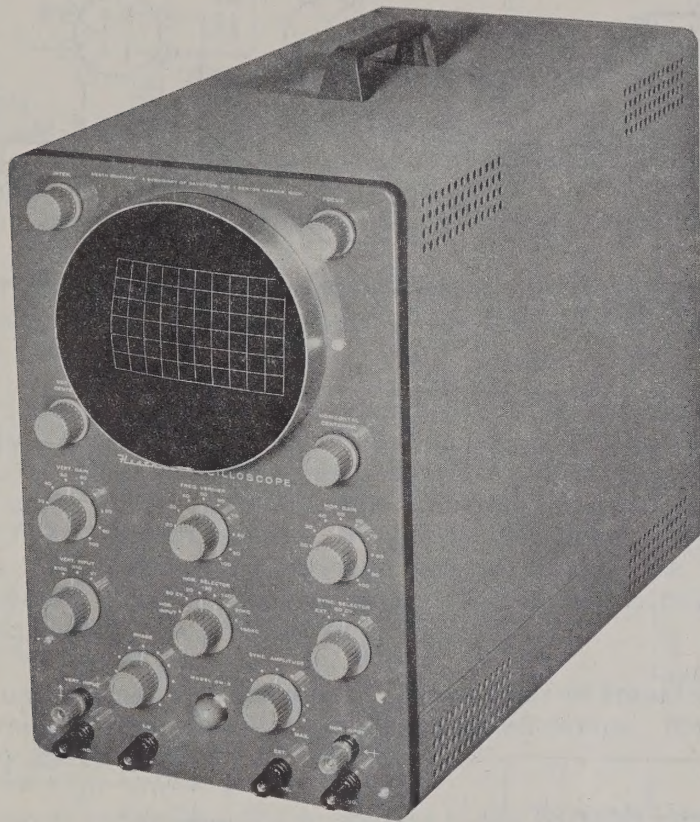
The tolerance rating of capacitors is determined by the color code. For example: red = 2%, green = 5%, etc. The voltage rating of capacitors is obtained by multiplying the color value by 100. For example: orange = 3 × 100 or 300 volts. Blue = 6 × 100 or 600 volts.

In the design of Heathkits, the temperature coefficient of ceramic or mica capacitors is not generally a critical factor and therefore Heathkit manuals avoid reference to temperature coefficient specifications.

Courtesy of Centralab

ASSEMBLY AND OPERATION OF THE HEATHKIT OSCILLOSCOPE

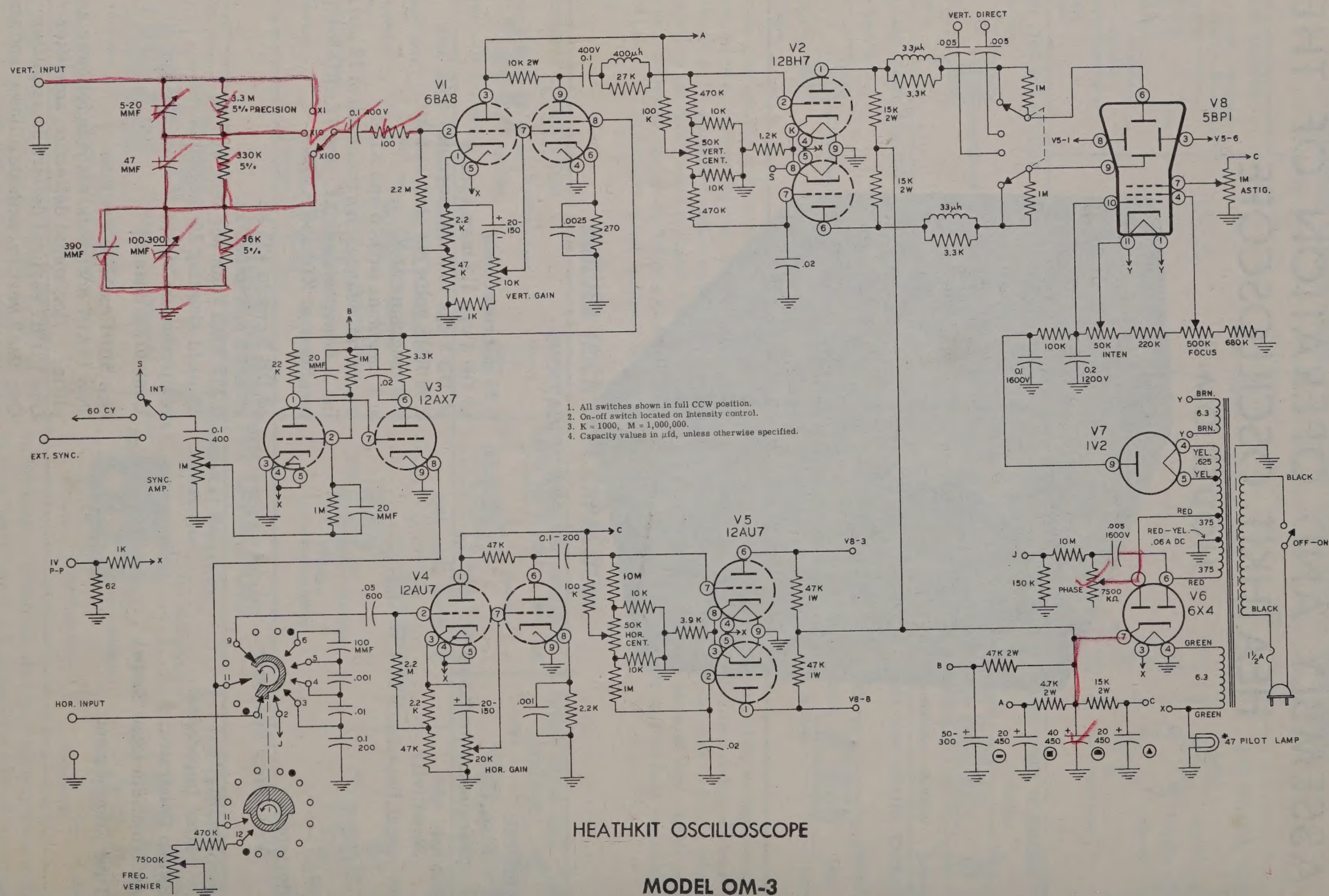
MODEL OM-3



SPECIFICATIONS

Vertical:	
Rise Time	0.25 microseconds
Frequency Response	±3 DB 4 cps 1.2 megacycles ±6 DB 3 cps to 2 megacycles
Sensitivity	0.09 RMS volts per inch at 1 kc
Input Impedance at 1 kc.	2.6 megohms at X1 3.3 megohms at X10 and X100 These impedances are the result of 22 $\mu\mu$f shunting 3.6 megohms at X1, and 11 $\mu\mu$f shunting 3.9 megohms at X10 and X100.
Horizontal:	
Frequency Response	±3 DB 2 cps to 425 kc ±6 DB 1 cps to 650 kc
Sensitivity	0.275 RMS volts per inch at 1 kc
Input Impedance	25 $\mu\mu$fd shunting 10 megohms
Sweep Generator:	Multivibrator 20 cps to over 150 kc
Astigmatism (Spot Shape):	Control on chassis
Tube Complement:	One 5BP1 cathode ray tube Two 12AU7 horizontal cathode follower and amplifier. Horizontal deflection amplifier One 12BH7 vertical deflection amplifier One 6BA8 vertical cathode follower and amplifier One 12AX7 sweep multivibrator One 6X4 low voltage rectifier One 1V2 high voltage rectifier

1/26/59



1. All switches shown in full CCW position.
2. On-off switch located on Intensity control.
3. K = 1000, M = 1,000,000.
4. Capacity values in μfd, unless otherwise specified.

HEATHKIT OSCILLOSCOPE

MODEL OM-3

Power Requirements:........................105-125 volts AC, 50/60 cycles, 65 watts

Dimensions:................................ 8 5/8" wide x 14 1/8" high x 18" deep

Net Weight:...................................18 lbs.

Shipping Weight:.............................22 lbs.

INSTRUMENT DESCRIPTION

The Heathkit model OM-3 Oscilloscope is a relatively wide band, general purpose oscilloscope, designed primarily for radio service, audio engineering, industrial electronics, production line testing, amateur radio, and hobbyist, in fact, and application where a stable, sensitive oscilloscope is needed, but where the more expensive, broadband oscilloscope is not required.

Featuring a wide vertical response, down approximately 6 DB at 2 megacycles, and a modern tube line-up, the model OM-3 represents a considerable advantage in performance for an oscilloscope in this price range.

The cathode ray oscilloscope is, without a doubt, one of the most versatile electronic instruments available today. It has earned this reputation because of its ability to display, in usable form, the instantaneous relationships between any two electrical quantities, no matter how complex, or between an electrical quantity and time. The oscilloscope can be used to evaluate differentials in voltage, current flow, phase, frequency, waveform and time. With the unlimited number of transducers available to the engineer today, it is a simple matter to convert any dynamic motion or static or dynamic physical quantity into an electrical signal which may then be displayed upon the screen of the oscilloscope.

Probably the major use of most oscilloscopes is in the study of transient or recurrent electrical phenomena. Since the oscilloscope is a voltage-operated device, these phenomena must first be converted into voltage excursions.

In normal use, the signal to be observed is applied to the vertical input terminals of the oscilloscope. By means of attenuators and/or amplifiers this signal voltage is made to displace vertically the electron beam in the cathode ray tube. Since, at the same time, the electron beam is being displaced horizontally and linearly with time by the internal sweep generator, the combined motion of the beam along both the X and Y axis traces out the instantaneous values of the signal voltage with respect to time.

NOTES ON CIRCUIT BOARD WIRING

In line with the Heath Company's policy of continual improvement of its instruments, your Heathkit model OM-3 Oscilloscope utilizes circuit board, or "printed circuit" wiring. The Heath Company was the first kit manufacturer to make use of this advanced technique in kit instruments.

The process of etching, printing or silk screening a wiring pattern on a circuit board is not an untried or experimental process. For years, one of the greatest hazards to quantity production of electronic equipment has been the variable "stray" inductances and capacities caused by the physical placement of leads and components. In critical circuits, these variations become an uncontrollable problem. During the first great expansion of television in the late 1940's, a television tuner was developed using printed-circuit tuned circuits. It was so successful that the technique was applied to millions of military electronic items where absolute uniformity, reliability and low cost were paramount considerations. Today, the advantages of circuit board wiring have made it an almost mandatory system for any commercial electronic manufacturer. Since dip-soldering of many connections at one time reduces labor cost, there is a decided economic advantage to the technique. In kit applications, dip-soldering is not practical of course. But even more important is the absolute uniformity of each unit.

It is this predictable uniformity that makes circuit-board wiring a major improvement in kit-constructed electronic instruments. For the first time, you can be sure that your oscilloscope will have the same characteristics as the development model. And, our engineers have been able to incorporate refinements in circuitry which otherwise would have been entirely swamped by the uncontrollable variables and strays introduced by conventional wiring.

HOW A CIRCUIT BOARD IS PRODUCED

It is important to understand how a circuit board is developed and manufactured so that you may fully realize its advantages. The board itself consists of a low-loss phenolic sheet. To one face of this sheet is bonded a layer of pure metallic copper. This bonding process is the result of years of research and development and has successfully passed the most rigid military requirements for electronic equipment. The bond is not affected by moisture, aging, etching solutions or normal variations in temperature.

The circuit pattern is developed after many experimental circuit layouts are tried and refined. The circuit is finally reduced to a drawing, bearing in mind necessary clearances for voltage breakdown, capacity effects, elimination of undesired feedback possibilities and a minimum of cross-overs. The final drawing, enlarged several times for greater accuracy, is photographed and a negative of exact size is produced. The copper surface of the circuit board is sensitized and exposed to light through the master negative. An etching process then removes all the copper except that protected by the opaque areas of the negative. The result is a copper "print" of the circuit pattern, as originally drawn.

Necessary holes are punched through the circuit board and circuit components are then mounted. For physical support, these parts are generally mounted on the phenolic side of the board with their leads passed through holes and soldered directly to the pattern. Soldering is simple and quick, using conventional methods.

One word of caution; we recommend that a small iron be used for circuit board soldering. The amount of heat required is much less than used for conventional wiring. Soldering pencils are ideal; a 25 or 50 watt iron is entirely adequate. Soldering guns should be used carefully, since they produce heat in direct ratio to length of time the switch is closed. Overheating can damage the circuit board and should be avoided. It is not necessary to "sweat" the connections. Any of the radio grades of solder work very well. DO NOT USE SOLDER PASTES OR OTHER EXTERNAL FLUXES, as they will completely ruin the circuit board.

GENERAL NOTES

UNPACK THE KIT CAREFULLY AND CHECK EACH PART AGAINST THE PARTS LIST. In so doing, you will become acquainted with the parts involved. Refer to the charts shown on the inside covers of the manual to help you identify any doubtful components. If some shortage is found in checking, please notify us promptly and return the inspection slip with your letter. Hardware items are counted by weight and if a few are missing, please obtain them locally if at all possible.

In order to expedite delivery to you, we are occasionally forced to make minor substitutions of parts. Such substitutions are carefully checked before they are approved and the parts supplied will work satisfactorily. By checking the parts list for resistors, for example, you may find that a 2.2 megohm resistor has been supplied in place of a 2 megohm as shown in the parts list. These changes are self-evident and are mentioned here only to prevent confusion to you in checking the contents of your kit.

We strongly urge that you follow the wiring and parts layout shown in this manual. The position of wires and parts is quite critical in this instrument and changes may seriously affect the characteristics of the circuit.

NOTES ON ASSEMBLY AND WIRING

The Heathkit Oscilloscope model OM-3 when constructed and used in accordance with the instructions in this manual, is a high quality instrument capable of many years of trouble-free service. Therefore, we urge you to assemble the kit carefully. Do not hurry the work and you will be rewarded with a greater sense of confidence in your ability and in your new Oscilloscope.

This manual is supplied to assist and guide you in every way possible to complete the kit with a minimum possibility of error. Each component has been identified pictorially and color codes and numerical values are specified each time a coded component is to be used. Elaborate pictorial diagrams and "step-by-step" wiring instructions are included to help you construct your kit with the greatest facility.

We suggest that you take a few minutes now and read the entire manual through before any work is started. This will enable you to proceed with the work much more rapidly when construction is begun. The large fold-in pictorials are handy to attach to the wall above your work space and their use will greatly simplify construction of this kit. These diagrams are also reproduced in smaller size within the manual. We suggest that you retain the manual in your files for future reference, both in the use of the Oscilloscope and for its maintenance.

Read the notes on soldering below. Crimp all leads tightly to the terminal before soldering. Be sure that both the lead and terminal are free of wax, corrosion or other foreign matter. Use only the best rosin core solder, preferably a type containing the new activated fluxes such as Kester "Radio-TV Solder," Ersin "Multicore" or similar types.

Resistors and controls generally have a tolerance of ±10% unless otherwise specified in the parts list. Therefore, a 100 KΩ control may test anywhere between 90 KΩ and 110 KΩ. (The letter K is commonly used to designate a multiplier of 1000.) Tolerance on capacitors are generally even greater. Limits of +100% and -50% are common for some types. The components furnished with your Heathkit have been specified to enable you to obtain maximum performance, accuracy and life from the completed instrument.

PROPER SOLDERING PROCEDURE

Only a small percentage of Heathkit purchasers find it necessary to return an instrument for factory service. Of these, by far the largest proportion function improperly due to poor or improper soldering.

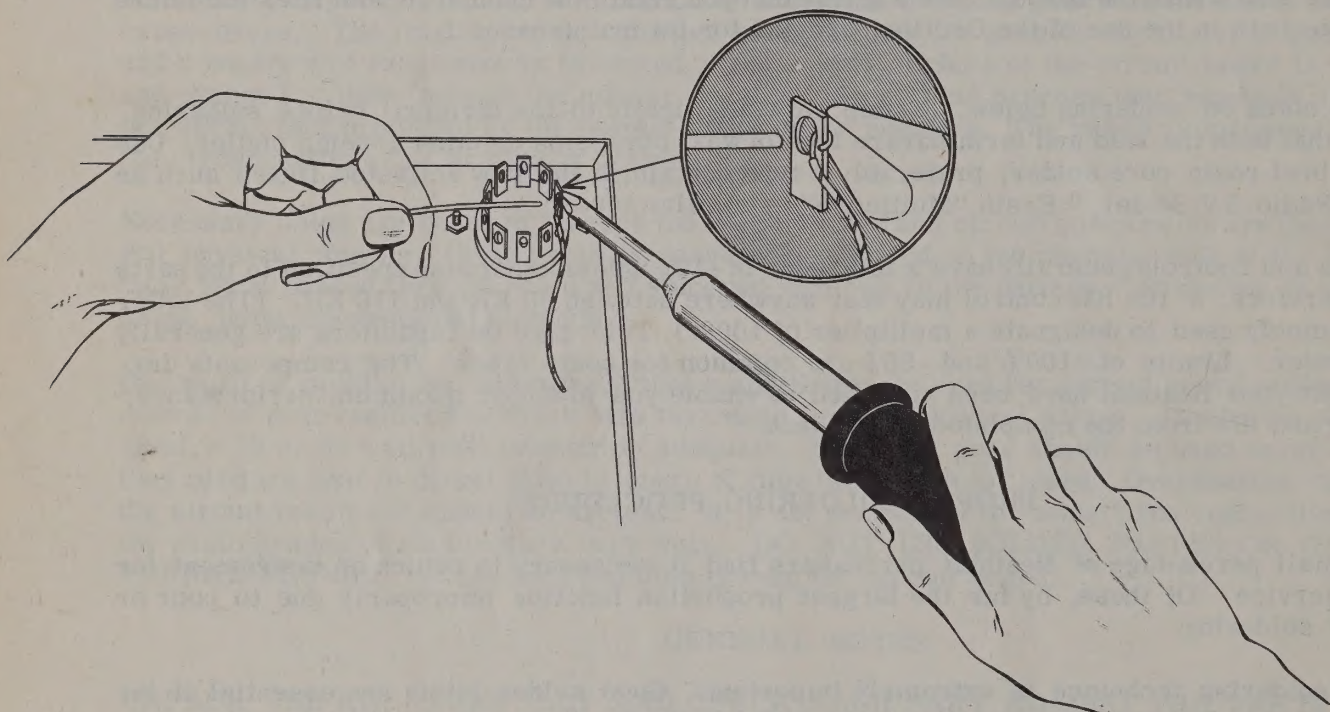
Correct soldering technique is extremely important. Good solder joints are essential if the performance engineered into the kit is to be fully realized. If you are a beginner with no experience in soldering, a half-hour's practice with odd lengths of wire and a tube socket will be a worthwhile investment.

High quality solder of the proper grade is most important. There are several different brands of solder on the market, each clearly marked "Rosin Core Radio Solder." Such solders consist of an alloy of tin and lead, usually in the proportion of 50:50. Minor variations exist in the mixture such as 40:60, 45:55, etc. with the first figure indicating the tin content. Radio solders are formed with one or more tubular holes through the center. These holes are filled with a rosin compound which acts as a flux or cleaning agent during the soldering operation.

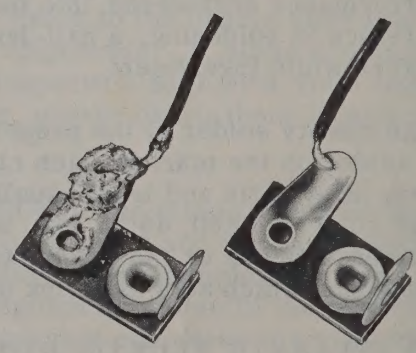
NO SEPARATE FLUX OR PASTE OF ANY KIND SHOULD BE USED. We specifically caution against the use of so-called "non-corrosive" pastes. Such compounds, although not corrosive at room temperatures, will form residues when heated. The residue is deposited on surrounding surfaces and attracts moisture. The resulting compound is not only corrosive but actually destroys the insulation value of non-conductors. Dust and dirt will tend to accumulate on these "bridges" and eventually will create erratic or degraded performance of the instrument.

NOTE: ALL GUARANTEES ARE VOIDED AND WE WILL NOT REPAIR OR SERVICE INSTRUMENTS IN WHICH ACID CORE SOLDER OR PASTE FLUXES HAVE BEEN USED. WHEN IN DOUBT ABOUT SOLDER, IT IS RECOMMENDED THAT A NEW ROLL PLAINLY MARKED "ROSIN CORE RADIO SOLDER" BE PURCHASED.

If terminals are bright and clean and wires free of wax, frayed insulation and other foreign substances, no difficulty will be experienced in soldering. Crimp or otherwise secure the wire (or wires) to the terminal, so a good joint is made without relying on solder for physical strength. To make a good solder joint, the clean tip of the soldering iron should be placed against the joint to be soldered so that the terminal is heated sufficiently to melt solder. The solder is then placed against both the terminal and the tip of the iron and will immediately flow out over the joint. Refer to the sketch below. Use only enough solder to cover wires at the junction; it is not necessary to fill the entire hole in the terminal with solder. Excess solder may flow into tube socket contacts, ruining the socket, or it may creep into switch contacts and destroy their spring action. Position the work so that gravity tends to keep the solder where you want it.



A poor solder joint will usually be indicated by its appearance. The solder will stand up in a blob on top of the connection, with no evidence of flowing out caused by actual "wetting" of the contact. A crystalline or grainy texture on the solder surface, caused by movement of the joint before it solidified is another evidence of a "cold" connection. In either event, reheat the joint until the solder flows smoothly over the entire junction, cooling to a smooth, bright appearance. Photographs in the adjoining picture clearly indicate these two characteristics.



A good, clean, well-tinned soldering iron is also important to obtain consistently perfect connections. For most wiring, a 60 or 100 watt iron, or the equivalent in a soldering gun, is very satisfactory. Smaller irons generally will not heat the connections enough to flow the solder smoothly over the joint and are recommended only for light work, such as on etched circuit boards, etc. Keep the iron tip clean and bright. A pad of steel wool may be used to wipe the tip occasionally during use.

Take these precautions and use reasonable care during assembly of the kit. This will insure the wonderful satisfaction of having the instrument operate perfectly the first time it is turned on.

STEP-BY-STEP ASSEMBLY AND WIRING

A space is provided in front of each step so that you can check off each operation as it is completed. This method will prevent confusion if your work is interrupted.

Unless otherwise specified, always use the standard 6-32 x 3/8" screws with #6 lockwashers under the 6-32 nuts for the installation of parts.

(✓) Refer to Pictorials 1 and 2 on Page 8. Connect the CR tube support bracket to the chassis using 6-32 hardware. At position A, install a 3-lug terminal strip under the lockwasher. At position B, use a #6 solder lug instead of a lockwasher. Mount the fuse block at position F. Place these components as shown in Pictorial 1.

(✓) Install a 2-lug terminal strip at C.

(✓) Install a 2-lug terminal strip at D.

(✓) Using 3-48 screws and nuts (no lockwashers), mount the 7-pin miniature tube socket at V6. The flat side of the socket must be placed against the underside of the chassis as shown in Pictorial 1. The blank space between pins 1 and 7 should be positioned as shown.

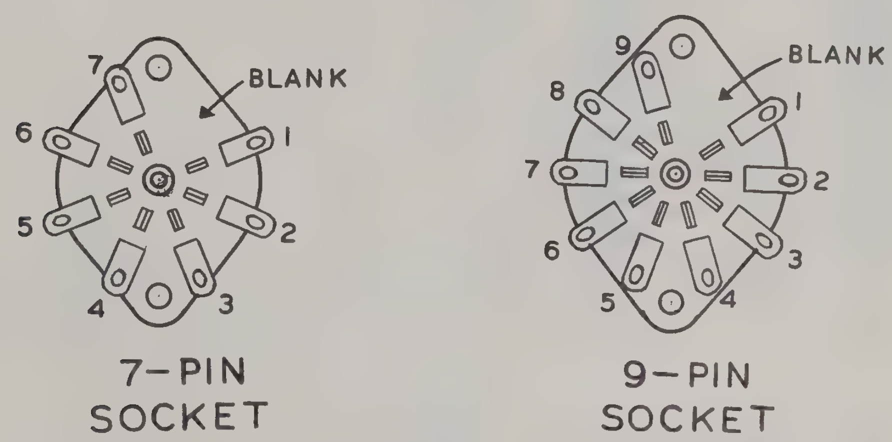


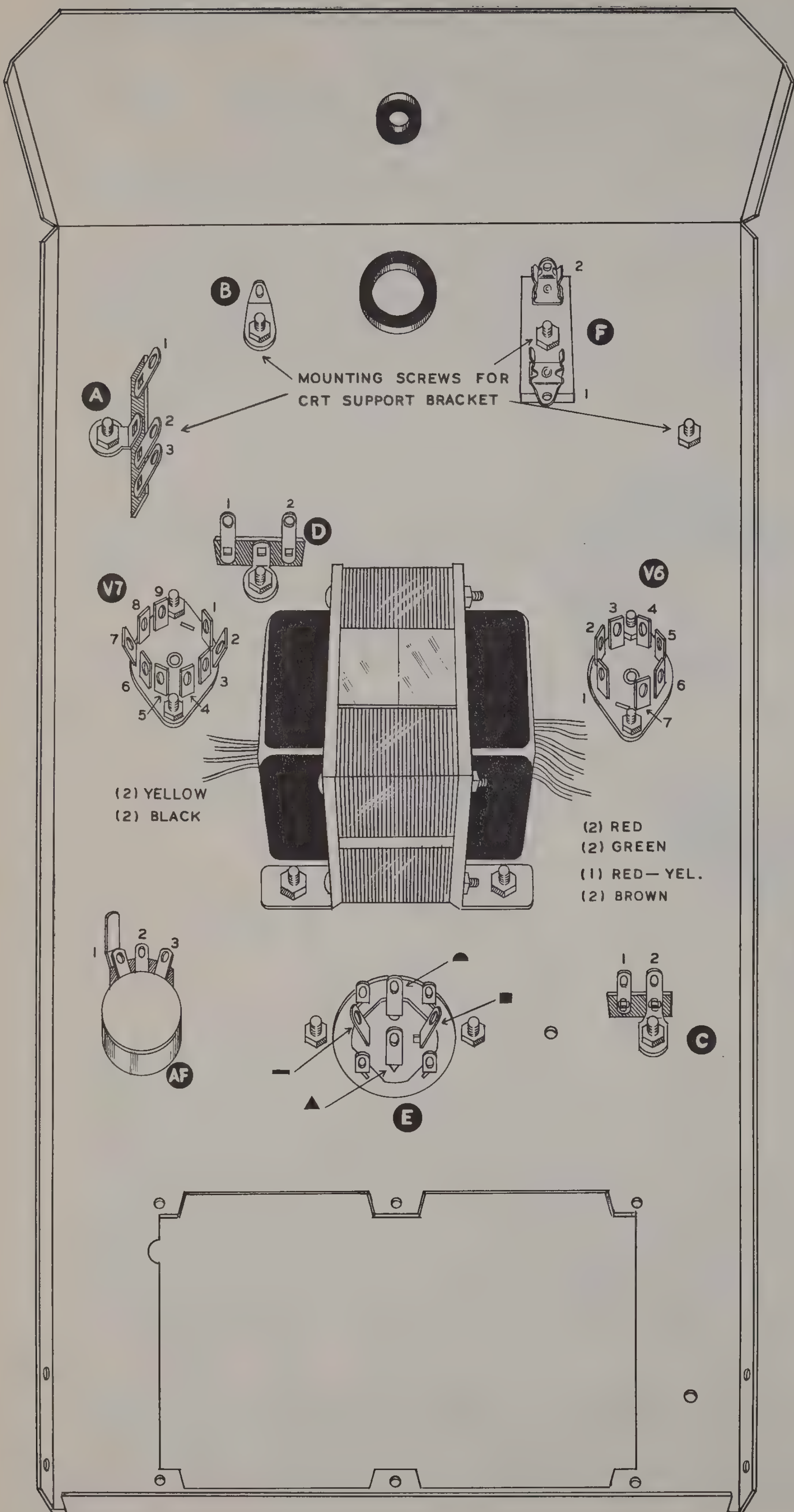
Figure 1

(✓) In the same manner, install the 9-pin miniature tube socket at V7. Note the positioning of the blank space between pins 1 and 9.

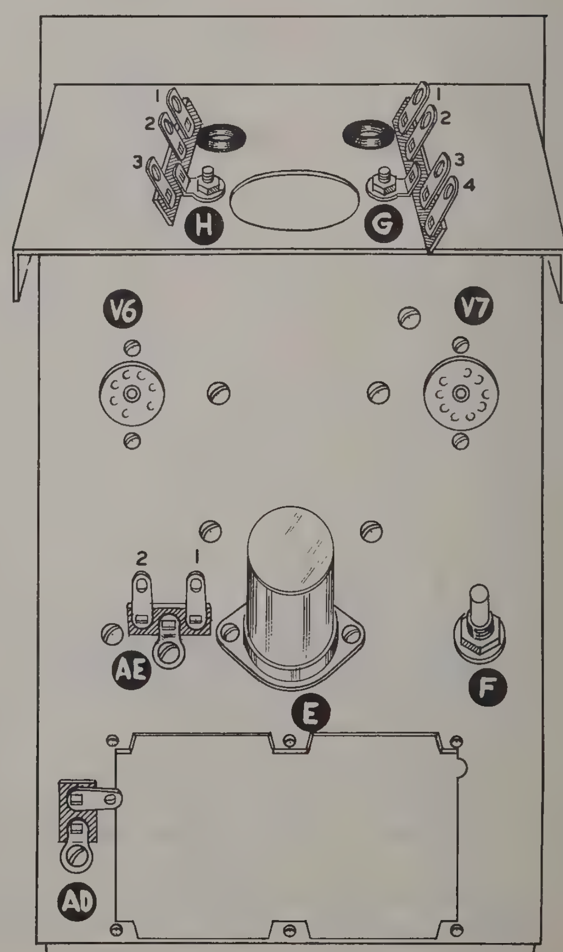
(✓) Install the metal capacitor mounting wafer at E. The wafer should lie against the top side of the chassis as shown.

(✓) Insert a 3/8" rubber grommet in the center hole in the large chassis skirt.

(✓) Insert a 3/4" rubber grommet in the hole directly below the large chassis skirt in Pictorial 1.

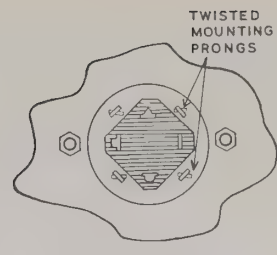


PICTORIAL 1



PICTORIAL 2

( ) From the top side of the chassis, insert the electrolytic filter capacitor 25-32, into the capacitor mounting wafer at E. Carefully identify the four inner lugs and position them as shown. While holding the capacitor firmly in place, twist each of the four mounting prongs about 1/8" turn. This will secure the filter capacitor in place.



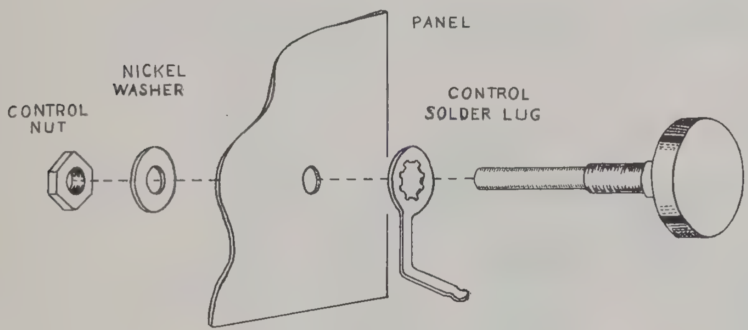
CONDENSER LUG MARKINGS

Figure 2

( ) Mount a 2-lug terminal strip at AE, using 6-32 hardware.

( ) Mount a 1-lug terminal strip at AD, using 6-32 hardware.

( ) Mount the 1 megohm astigmatism control at AF, using a control solder lug and control nut. Solder AF1 to the control solder lug.



HOW TO MOUNT CONTROLS
USING A CONTROL SOLDER LUG

Figure 3

( ) Examine the power transformer and identify the color-coded wires coming out on either side. Install the transformer using 8-32 hardware. All yellow and black leads should come out near the 9-pin socket.

( ) Referring to Pictorial 2 and Figure 4, mount the 4-lug terminal strip on the CR tube support bracket at G. Be sure to include one of the small angle brackets, and use two lockwashers as shown.

( ) In the same manner, install a 3-lug terminal strip and the other angle bracket at H.

( ) Now insert 3/8" rubber grommets in the two 3/8" holes in the CR tube support bracket.

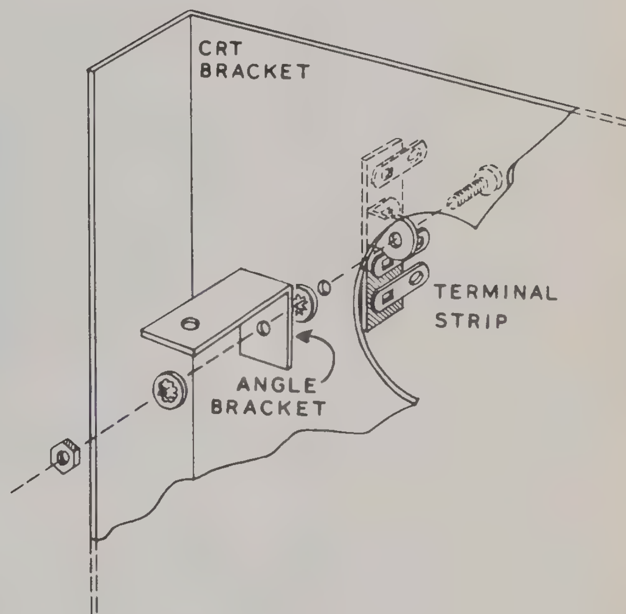


Figure 4

All wire referred to is insulated hookup wire unless otherwise specified. The ends should be stripped of insulation about 1/4". (S) means to solder the terminal immediately, making sure that the solder contacts all wires connected to that terminal. (NS) means do not solder yet because other connections are to be made to that terminal.

( ) At the low voltage filter capacitor E, solder any one of the four twisted mounting prongs to the metal capacitor mounting wafer. This will maintain a good ground connection for the filter circuit.

( ) Connect a wire from lug E▬ (NS) to V6-7 (S).

NOTE: All resistors have a 1/2 watt rating unless otherwise specified. They are the smallest size with a body length of 3/8" and a diameter of 1/8". 1 watt resistors are 9/16" long and have a diameter of 7/32". 2 watt resistors are about 11/16" long and have a diameter of 5/16". Be sure to use the correct size in each position. Unless otherwise stated, disregard the "outside foil" markings on tubular capacitors.

( ) Connect a 47 KΩ 2 watt resistor (yellow-violet-orange) from E▬ (NS) to E- (NS).

( ) Connect a 4.7 KΩ 2 watt resistor (yellow-violet-red) from E▬ (NS) to E■ (NS).

( ) Now connect a 15 KΩ 2 watt resistor (brown-green-orange) from E▬ (NS) to E▲ (NS).

( ) Connect a wire from V6-4 (NS) to C2 (NS).

( ) Connect a .005 μfd 1600 volt DC disc capacitor to V6-2 (NS). Wire the other lead to V6-6 (NS).

( ) Connect the red-yellow lead coming out of the power transformer to C2 (NS).

( ) Twist the two red transformer leads together and connect either one to V6-1 (NS). Wire the other red lead to pin 6 (S) of the same socket.

( ) Twist the two green transformer leads together and connect either one to V6-3 (NS). Connect the other green lead to V6-4 (S).

( ) Twist the two yellow leads together and connect either one to V7-5 (S). Wire the other yellow lead to pin 4 (S) of the same socket.

( ) Twist the black leads together and dress them along the side of the chassis as shown. Connect either black lead to A2 (NS). Wire the other black lead to A3 (NS).

( ) Twist the two brown leads together and dress them along the chassis. Run the brown leads through the large 3/4" grommet near the chassis skirt. Connect either brown lead to G4 (NS) on the CR tube support bracket. The other brown lead is then wired to G3 (NS).

( ) Identify the cable assembly consisting of color-coded wires. At one end there will be only four free wires colored orange, red, yellow and blue. Insert this end of the cable through the large 3/4" grommet from the underside of the chassis. These cabled wires are already cut to proper length and stripped. On the CR tube support bracket, connect the yellow wire to G3 (NS). See Pictorial 4.

( ) Connect the red wire to G2 (NS).

( ) Connect the blue wire to H2 (NS).

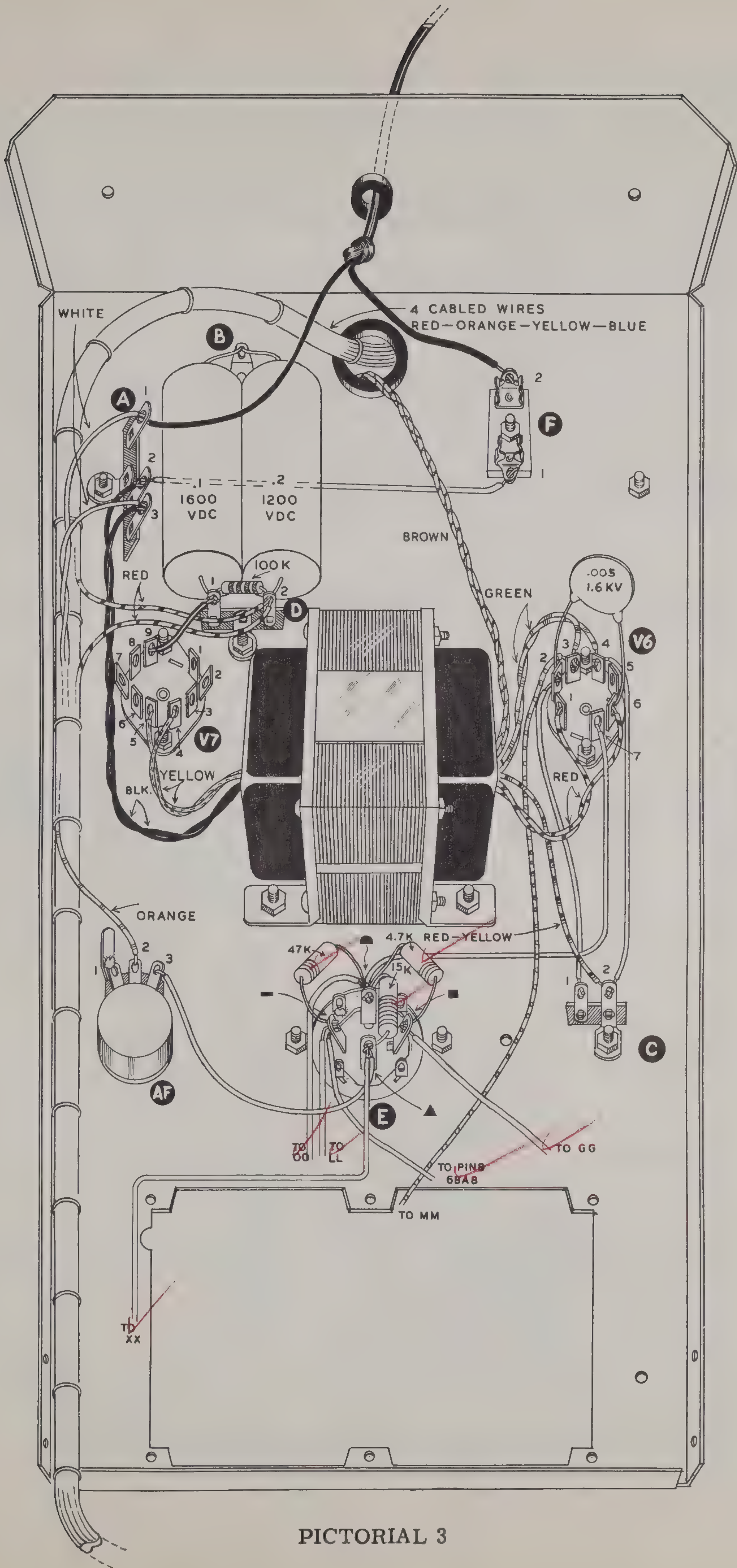
( ) Connect the orange wire to H1 (NS).

( ) On the underside of the chassis, dress the cable down the chassis edge.

( ) Coming out of the cable will be two white, an orange and two red leads. Connect either white lead to A1 (NS).

( ) Connect the other white lead to A3 (S).

( ) Dress both of the red leads between socket V7 and terminal strip D as shown. Connect both red leads to D2 (NS).


4 CABLED WIRES
RED—ORANGE—YELLOW—BLUE
WHITE
B
A
F
.1
1600
VDC
.2
1200
VDC
BROWN
100 K
RED
D
GREEN
.005
1.6 KV
V6
V7
YELLOW
BLK.
RED
ORANGE
47K
4.7K
RED—YELLOW
15K
C
AF
E
TO OO
TO LL
TO PIN 8
6BA8
TO GG
TO MM
TO XX

PICTORIAL 3

( ) Connect the orange lead to AF2 (S).

( ) Select the line cord and tin each lead end to hold the copper strands together and make soldering easier.

( ) Insert the line cord into the chassis through the 3/8" rubber grommet in the chassis skirt. Tie a knot in the cord about 6" from the end for strain relief. Connect either lead to A1 (S). Wire the other lead to F2 (S).

( ) Connect a wire from E▲ (NS) to AF3 (S).

( ) Connect a wire from A2 (S) to F1 (S).

( ) Position the .1 μfd 1600 volt DC paper tubular capacitor as shown and connect one lead to solder lug B (NS). Pass the other lead through D1 (NS) to V7-9 (S) (use sleeving).

( ) In the same manner, connect either lead of the .2 μfd 1200 volt DC paper tubular capacitor to solder lug B (S). Wire the other lead to D2 (NS).

( ) Now connect a 100 KΩ resistor (brown-black-yellow) from D1 (S) to D2 (S).

( ) Lay aside the chassis for the time being and set up the "direct input bracket" as shown. Install the DPDT slide switch SW, using 6-32 hardware.

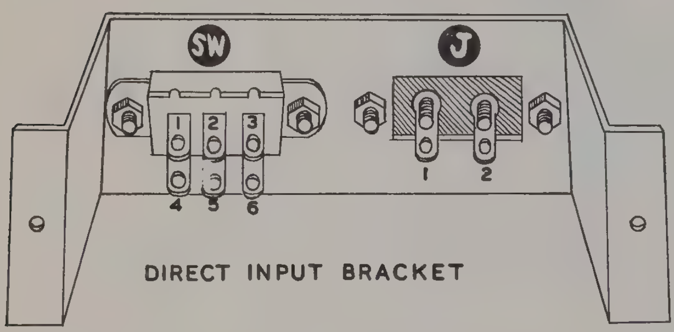


Figure 5

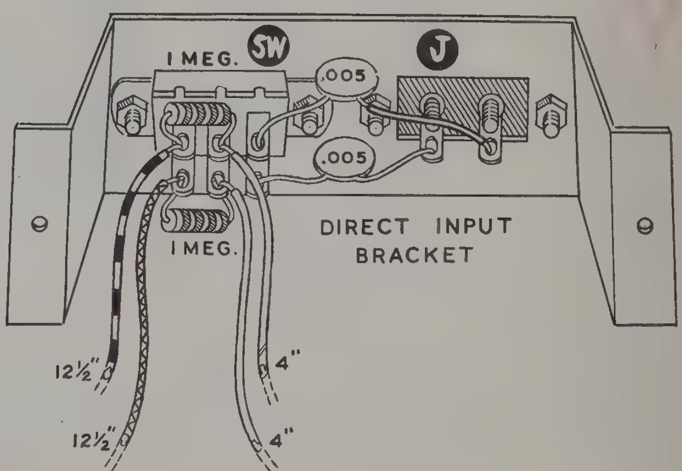


Figure 6

( ) Now install the 2-screw terminal strip J from the opposite side of the bracket so that the lugs extend through the bracket hole.

( ) Connect a .005 μfd disc capacitor from SW6 (S) to J1 (S). Dress as shown.

( ) Connect another .005 μfd disc capacitor from SW3 (S) to J2 (S) (use sleeving).

( ) Wire a 1 megohm resistor (brown-black-green) from SW1 (NS) to SW2 (NS).

( ) Connect another 1 megohm resistor from SW4 (NS) to SW5 (NS).

(✓) Connect one end of a 12 1/2" piece of wire to SW1 (S). Leave the other end free.

(✓) Connect one end of a 12 1/2" piece of wire to SW4 (S). Leave the other end free.

(✓) Connect a 4" piece of wire to SW2 (S). Leave the other end free.

(✓) Connect a 4" piece of wire to SW5 (S). Leave the other end free.

(✓) The long leads attached to lugs 1 and 4 of switch SW can now be inserted through the 3/8" grommet near terminal strip H on the CR tube bracket as shown. Now install the direct input bracket on the CR tube bracket using 6-32 hardware.

(✓) Connect the free end of the lead from SW2 to pin 9 (S) of the 11-pin CRT socket. Refer to Pictorial 4 for proper positioning.

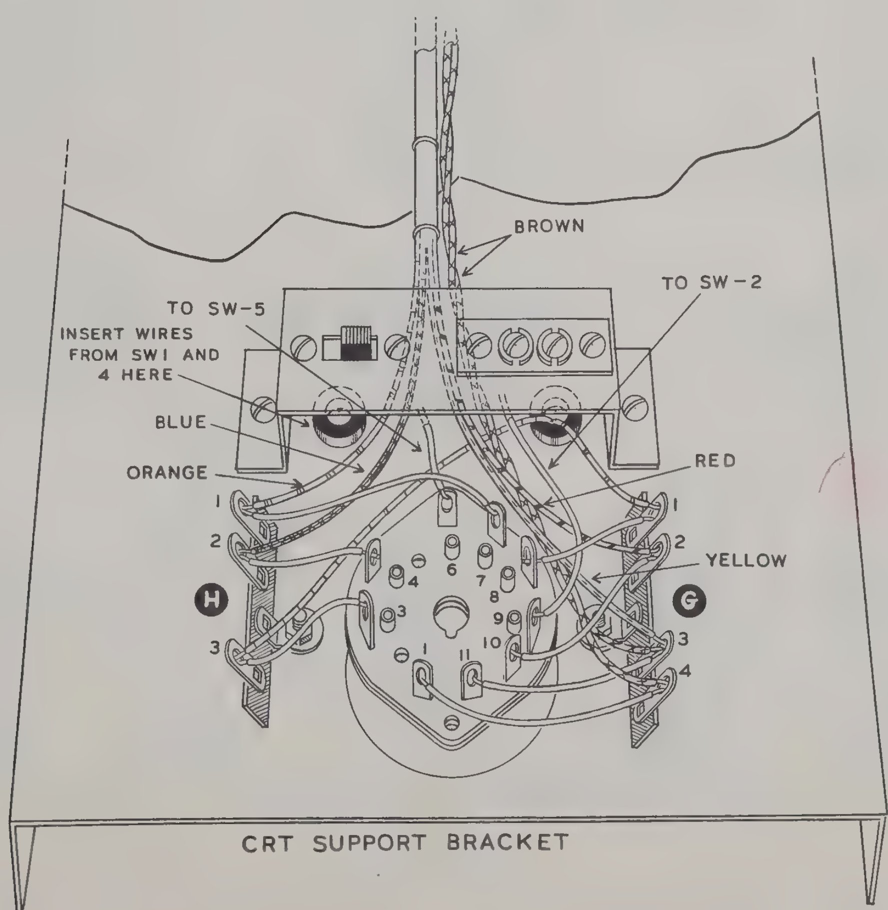
(✓) Connect the short lead from SW5 to pin 6 (S) of the CRT socket.

(✓) Connect one end of a 16 1/2" piece of wire to H3 (NS). Pass the other end of the wire under the colored cable wires and run it through the 3/8" grommet located near terminal strip G. Leave this end free.

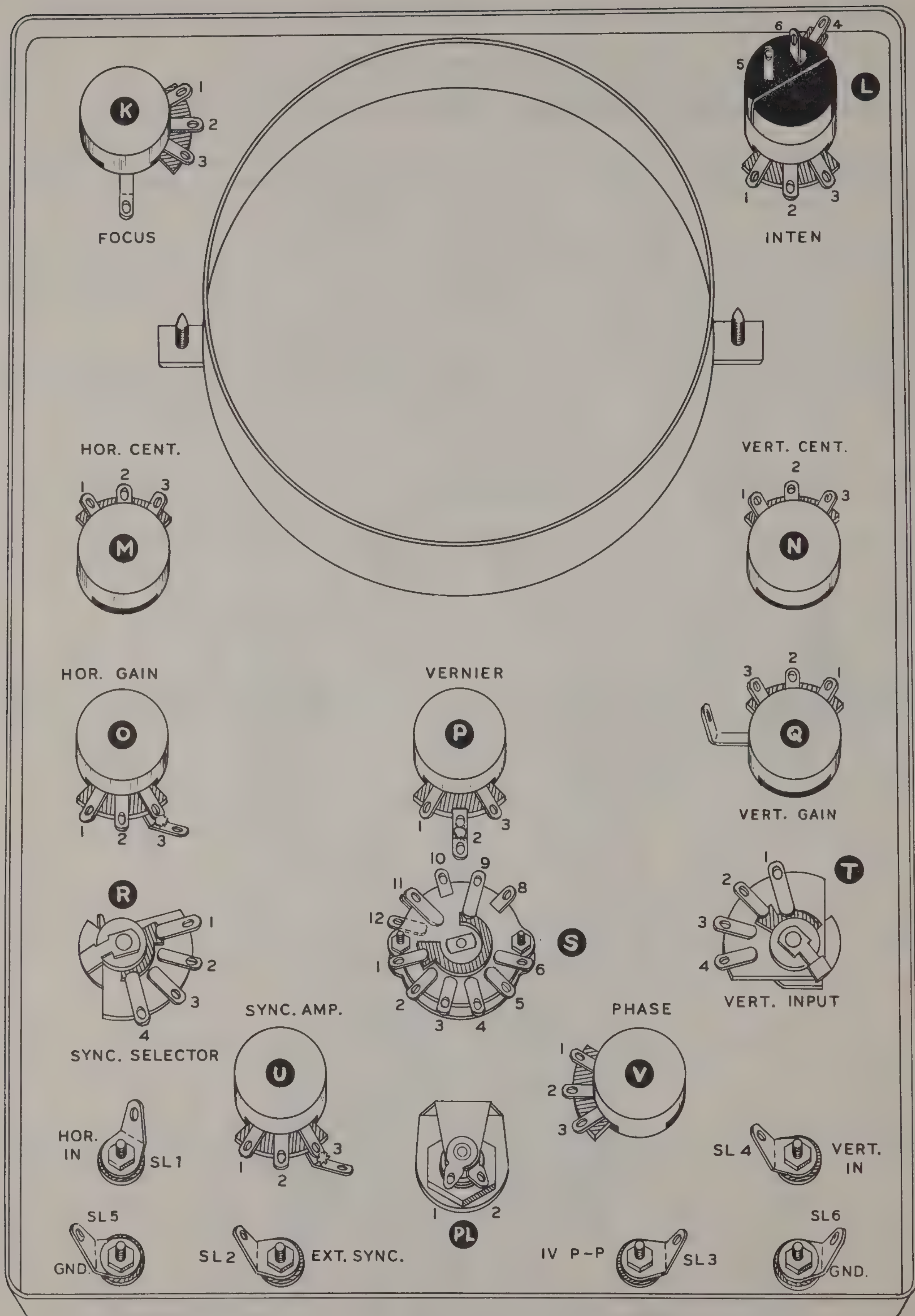
(✓) Now connect one end of a 14" piece of wire to G1 (NS). Insert the other end through the same grommet near G and leave this end free.

(✓) Cut and strip both ends of seven pieces of wire, each of which should be 4" long. Connect the first wire from G1 (S) to pin 8 (S) of the CRT socket.

(✓) Connect the second wire from G2 (S) to pin 10 (S) of the CRT socket.



PICTORIAL 4



K
FOCUS
L
INTEN
HOR. CENT.
M
VERT. CENT.
N
HOR. GAIN
O
VERNIER
P
Q
VERT. GAIN
R
SYNC. SELECTOR
S
T
VERT. INPUT
SYNC. AMP.
U
PHASE
V
HOR. IN
SL 1
SL 4
VERT. IN
SL5
GND.
SL 2
EXT. SYNC.
PL
IV P-P
SL 3
SL6
GND.

PICTORIAL 5

(✓) The third wire should now be connected from G3 (S) to pin 11 (S) of the CRT socket.

(✓) Connect the fourth wire from G4 (S) to pin 1 (S) of the CRT socket.

(✓) Connect the fifth wire from H2 (S) to pin 4 (S) of the CRT socket.

(✓) Connect the sixth wire from H3 (S) to pin 3 (S) of the CRT socket.

(✓) Connect the seventh wire from H1 (S) to pin 7 (S) of the CRT socket.

NOTE: When installing controls and switches, flatten out any locating prong that might interfere with a secure mounting to the panel.

(✓) Refer to Pictorial 5 on Page 14 and begin the assembly of the parts to the front panel. Install the 500 KΩ FOCUS control at K. Use a control solder lug instead of a control lockwasher. Position the lugs as shown.

(✓) Now install the 50 KΩ INTEN. control at L. Notice that this control has two extra lugs at the rear and one extra on the side.

(✓) Install the 50 KΩ HORIZONTAL CENTERING control at M.

(✓) Install the 50 KΩ VERTICAL CENTERING control at N.

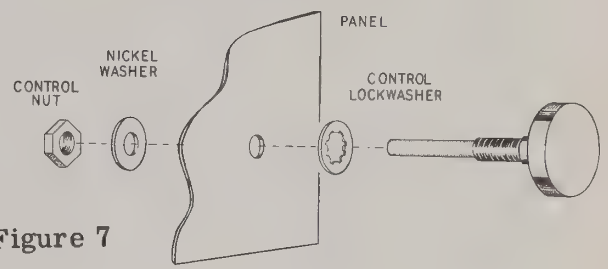


Figure 7

HOW TO MOUNT CONTROLS & SWITCHES

(✓) Using a control solder lug, mount the 20 KΩ HOR. GAIN control at O. Bend the control solder lug back to contact lug 3 and solder.

(✓) Use another control solder lug and install the 7500 KΩ FREQ. VERNIER control at P. Bend back the control solder lug and solder it to lug 2 of the control.

(✓) Install the 10 KΩ VERT. GAIN control at Q, using a control solder lug, flat washer and nut.

(✓) Install one of the 3-position rotary switches 63-47 at position R. Orient the lugs as shown.

(✓) Similarly, mount the other 3-position switch at T.

(✓) Now install the 6-position rotary switch 63-83 at position S. Before tightening the control nut, rotate the switch so that lugs 9 and 10 are closest to the FREQ. VERNIER control P.

(✓) Refer to Figure 8 and mount the pilot light assembly at PL. The bushing, lamp and jewel are installed from the front of the panel.

(✓) Now install the 1 megohm SYNC. AMPLITUDE control at U. Use a control solder lug, and solder it to U3.

(✓) Install the 7500 KΩ PHASE control at V.

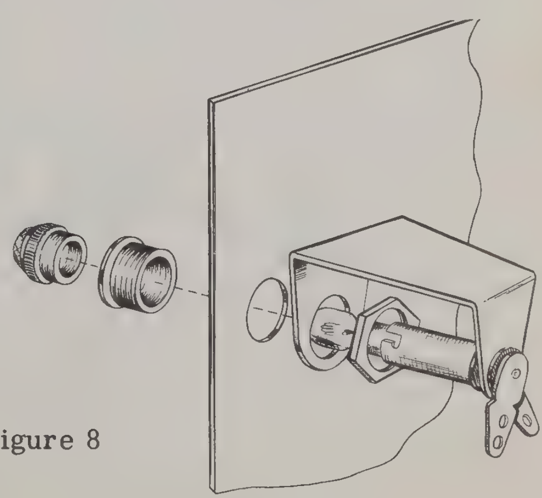
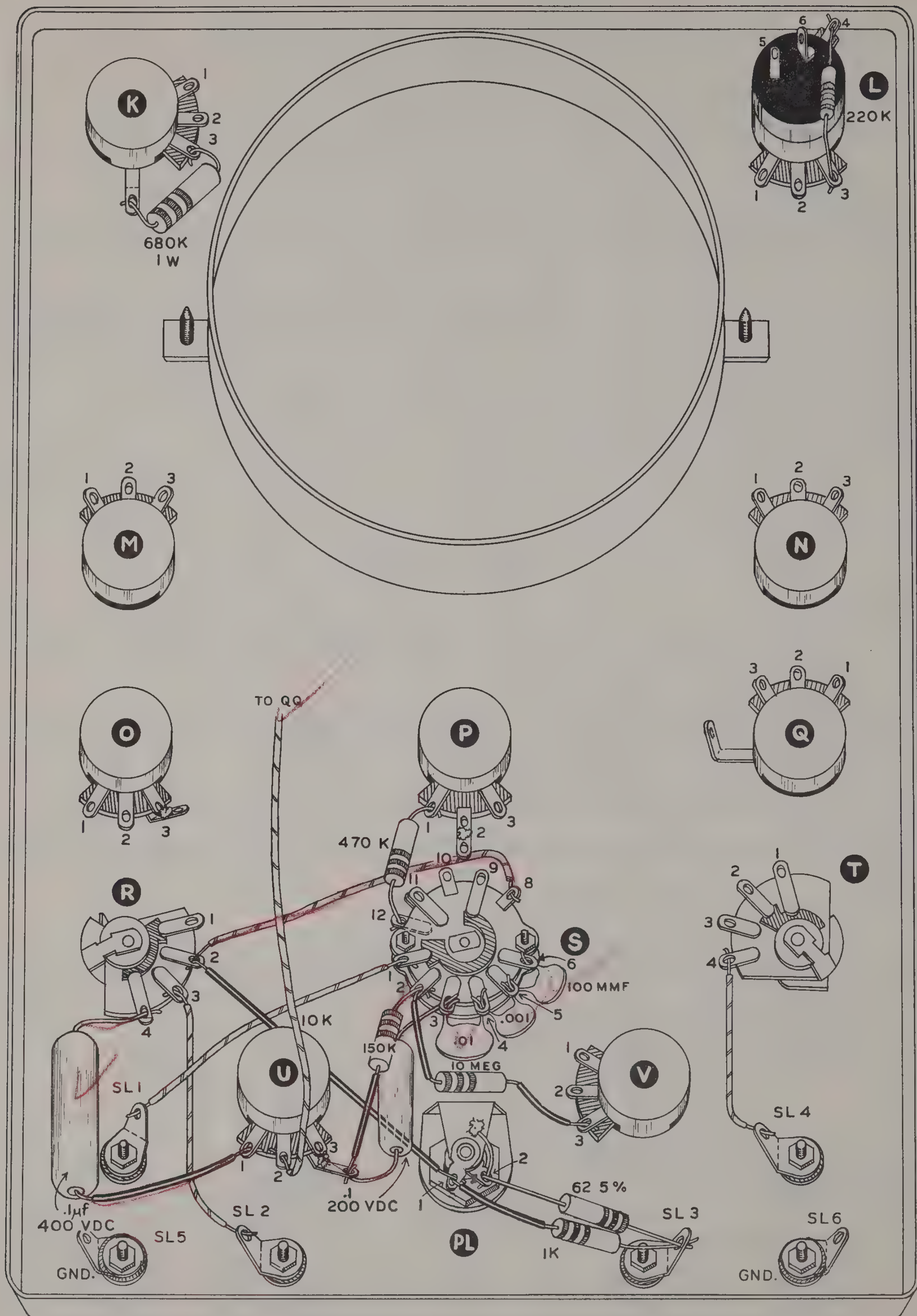


Figure 8

PILOT LIGHT ASSEMBLY


K
680K
1 W
L
220K
M
N
O
P
Q
R
S
T
U
V
PL
TO QQ
470 K
10K
150K
10 MEG
100 MMF
.001
.01
.1
200 VDC
.1µf
400 VDC
62 5%
1K
SL 1
SL 2
SL 3
SL 4
SL5
SL6
GND.
GND.

PICTORIAL 6

(✓) Install binding post bases in each of the six holes at the bottom of the panel. Refer to Figure 9 and use the insulator bushings with a #6 solder lug under the nut. Position the solder lugs as shown in Pictorial 5 at positions SL1, SL2, SL3, SL4, SL5 and SL6.

(✓) Mount the CR tube ring as shown. The mounting brackets should rest against the inside surface of the panel and the seam in the ring should be downward. Secure with #6 sheet metal screws.

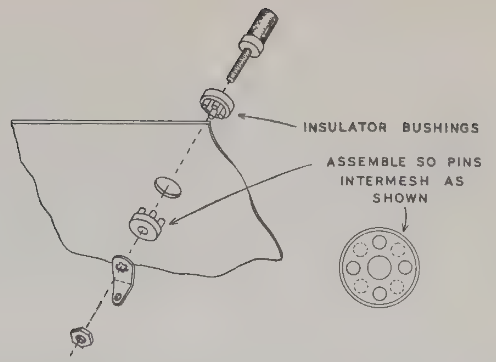


Figure 9

(✓) Connect a 220 KΩ resistor (red-red-yellow) from L3 (S) to L4 (NS). Dress as shown in Pictorial 6.

(✓) Connect a 680 KΩ 1 watt resistor (blue-gray-yellow) from K3 (S) to the control solder lug (S) at K.

(✓) Connect a 470 KΩ resistor (yellow-violet-yellow) from P1 (S) to S12 (S).

(✓) Connect either lead of a .1 μfd 400 volt DC capacitor to U1 (S) (use sleeving). Dress the capacitor as shown and connect its other lead to R4 (S).

(✓) Connect a wire from R3 (S) to solder lug SL2 (S).

(✓) Connect a wire from R2 (NS) to PL1 (NS).

(✓) Connect a 100 μμf disc type capacitor from S6 (S) to S5 (NS).

(✓) Connect a .001 μfd disc type capacitor from S5 (S) to S4 (NS).

(✓) Connect a .01 μfd disc type capacitor from S4 (S) to S3 (NS).

(✓) Connect either lead of a .1 μfd 200 volt DC capacitor to the control solder lug (NS) under the SYNC. AMPLITUDE control U. Connect the other lead to S3 (S).

( ) Connect a 150 KΩ resistor (brown-green-yellow) from the same control solder lug (S) at U to S2 (NS).

(✓) Connect a 10 megohm resistor (brown-black-blue) from S2 (S) to V3 (NS) (use sleeving).

(✓) Connect a wire from S1 (S) to the solder lug SL1 (S).

(✓) Connect a 1 KΩ resistor (brown-black-red) from solder lug SL3 (NS) to PL1 (S) (use sleeving).

(✓) Connect a 62 Ω 5% resistor (blue-red-black-gold) from SL3 (S) to PL2 (NS).

(✓) Remove the insulation from a short piece of wire and connect PL2 (S). Solder the other end of the frame of the pilot light socket as shown.

(✓) Now connect a wire from solder lug SL4 (NS) to T4 (S).

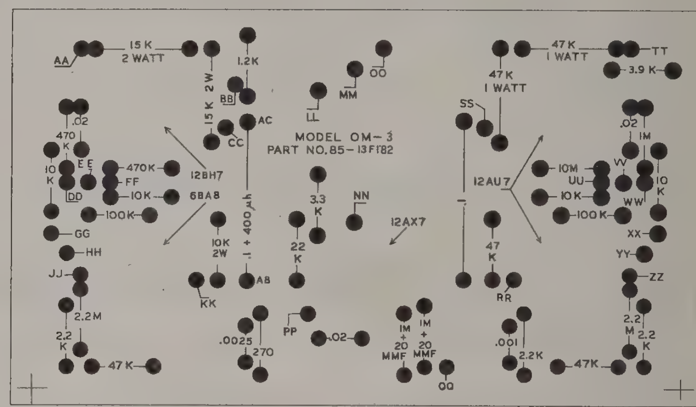
CIRCUIT BOARD ASSEMBLY

The values and locations of all components to be mounted on the circuit board are printed on the board itself for your convenience. To anyone experienced in this relatively new wiring method, this information will be self-explanatory. All parts, including five 9-pin sockets, are inserted into the board from the printed side. They are then soldered to the etched side of the board and resistor and capacitor leads are then clipped to a length of about 1/8". Of course, the sockets must be rotated until the blank space between pins 1 and 9 correspond to the blank space in the metal circuit pattern.

The following method of construction has been found to be most practical and it is suggested that you proceed in this sequence.

First select the twenty-three 1/2 watt resistor values to be installed on the circuit board and bend each lead to a 90° angle as close as possible to the resistor body. The values are as follows:

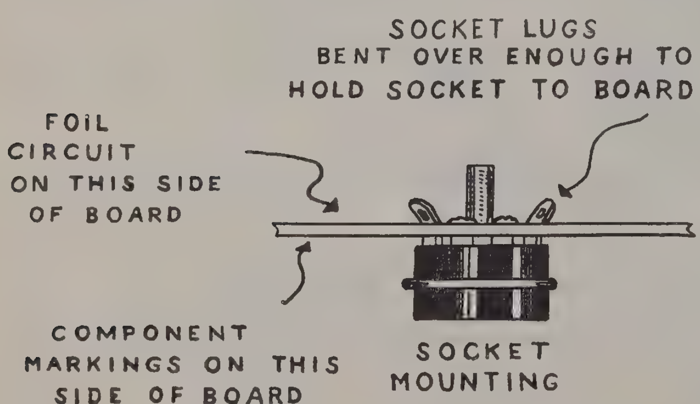
2 - 2.2 megohm (red-red-green)
3 - 2.2 KΩ (red-red-red)
3 - 47 KΩ (yellow-violet-orange)
2 - 100 KΩ (brown-black-yellow)
1 - 270 Ω (red-violet-brown)
2 - 470 KΩ (yellow-violet-yellow)
4 - 10 KΩ (brown-black-orange)
1 - 1.2 KΩ (brown-red-red)
1 - 22 KΩ (red-red-orange)
1 - 3.3 KΩ (orange-orange-red)
1 - 1 megohm (brown-black-green)
1 - 3.9 KΩ (orange-white-red)
1 - 10 megohm (brown-black-blue)



OM-3 CIRCUIT BOARD SCREEN 605—182

Figure 10

Install each resistor from the phenolic side of the board as shown. Make sure that the correct value is used in each position. Press each resistor in place until it lies against the circuit board itself. Turn the board over and solder each resistor lead to the metal surrounding the hole through which the lead protrudes. A small tipped iron with a rating of 25 watts to 50 watts should be used if possible. Soldering pencils are excellent. If a soldering gun is used, do not touch the tip to the circuit board until it is hot enough to solder immediately.



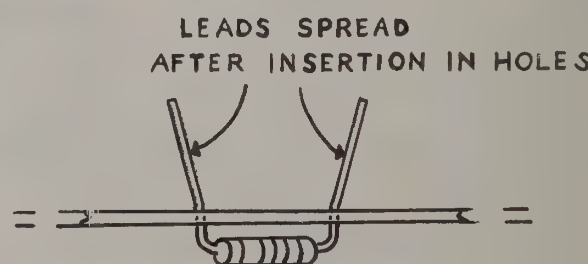


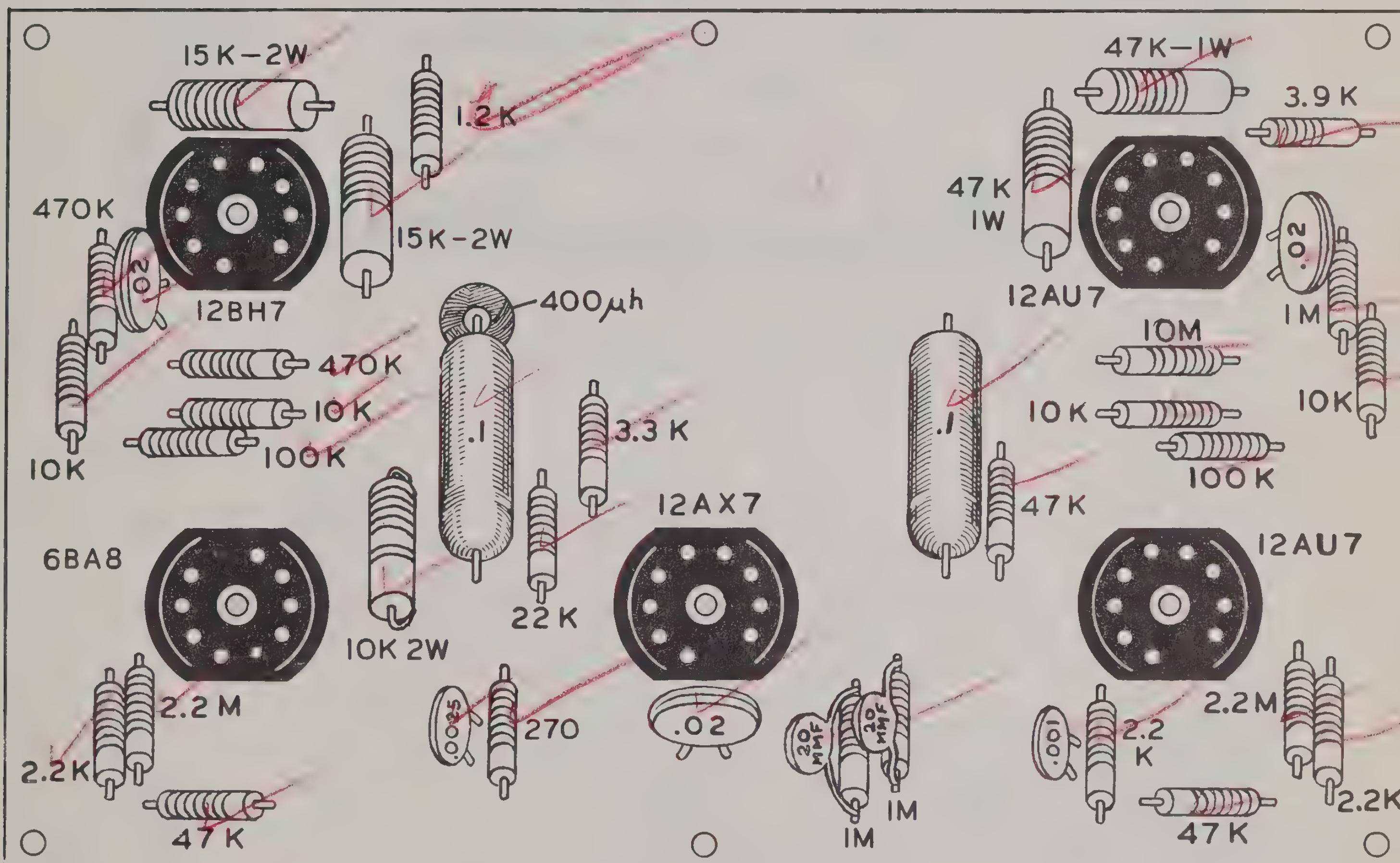
Figure 11

A convenient method is to solder as many leads as you can around the edges of the board. These leads can then be clipped off short so that more leads can be reached. In this way, you will soon have all 23 resistors soldered in place.

Proceed in the same manner to install and solder the following parts:

2 - 15 KΩ 2 watt resistors (brown-green-orange)
2 - 47 KΩ 1 watt resistors (yellow-violet-orange)
1 - .001 μfd disc capacitor
3 - .02 μfd disc capacitor
1 - .0025 μfd disc capacitor
1 - .1 μfd 200 volt DC tubular capacitor
1 - 10 KΩ 2 watt resistor (brown-black-orange)

NOTE: The 10 K 2 watt resistor should be spaced approximately 3/8" above the surface of the circuit board. The mounting holes have purposely been placed close together to prevent seating this resistor against the circuit board.



PICTORIAL 7

Before installing the sockets, each one should be "broken in" by inserting any 9-pin miniature tube several times. This will loosen up the pins and prevent possible damage to the circuit board through the use of heavy pressure when tubes are permanently installed.

(✓) Now install the five 9-pin miniature tube sockets from the component side of the board. Rotate each one for proper orientation of the blank space between pins 1 and 9. Bend each pin (except pin 8 of V1, pins 3 and 8 of V2 and V5 and pins 1 and 7 of V3) flat against its corresponding metal circuit pattern connection. Now solder the bent pins to the pattern.

(✓) Using short bare wires, connect pins 3 and 8 of V2, pins 3 and 8 of V5 and pins 1 and 7 of V3. Now solder the wires and the pins to the metal pattern. See Figure 12.

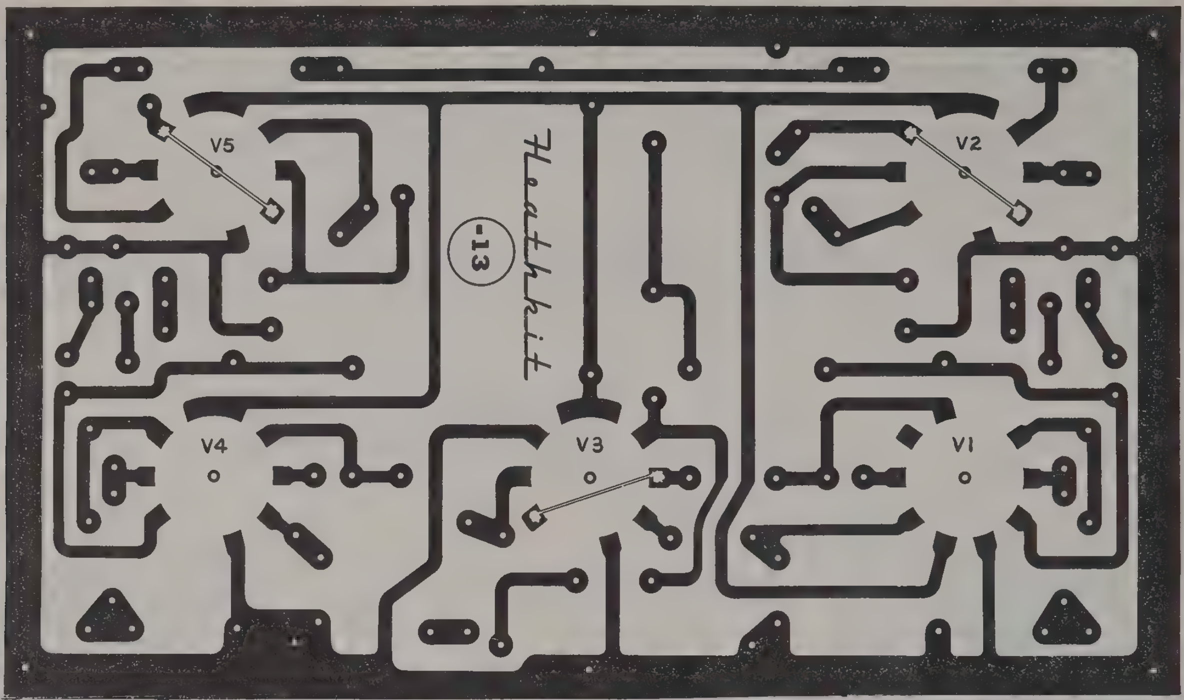


Figure 12

(✓) Prepare two resistor/capacitor combinations as shown in Figure 13 using one megohm resistor and a 20 $\mu\mu$fd ceramic capacitor for each combination. Solder the wrapped leads on each combination and clip off the excess RESISTOR leads.

( ) Insert each through the circuit board in the normal manner and solder.

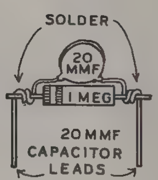


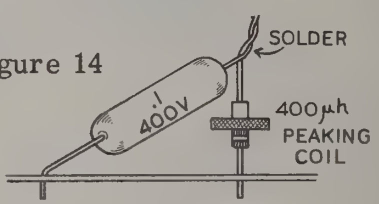
Figure 13

(✓) Insert one end of the .1 μfd 400 volt paper capacitor in hole AB, leaving approximately 3/8" of lead on the capacitor side of the board, and solder.

(✓) Insert one end of the 400 μh peaking coil (the single pie wound on a 1/2 watt resistor) into hole AC, again leaving 3/8" of lead next to the coil, and solder.

( ) Lightly twist together the remaining leads of the peaking coil and the .1 capacitor just installed, forming these two components into a triangle whose base is the circuit board. See Figure 14. Solder this connection, and clip off excess leads on both sides of the board. This configuration is necessary to preclude the possibility of distributed capacity in the peaking circuit.

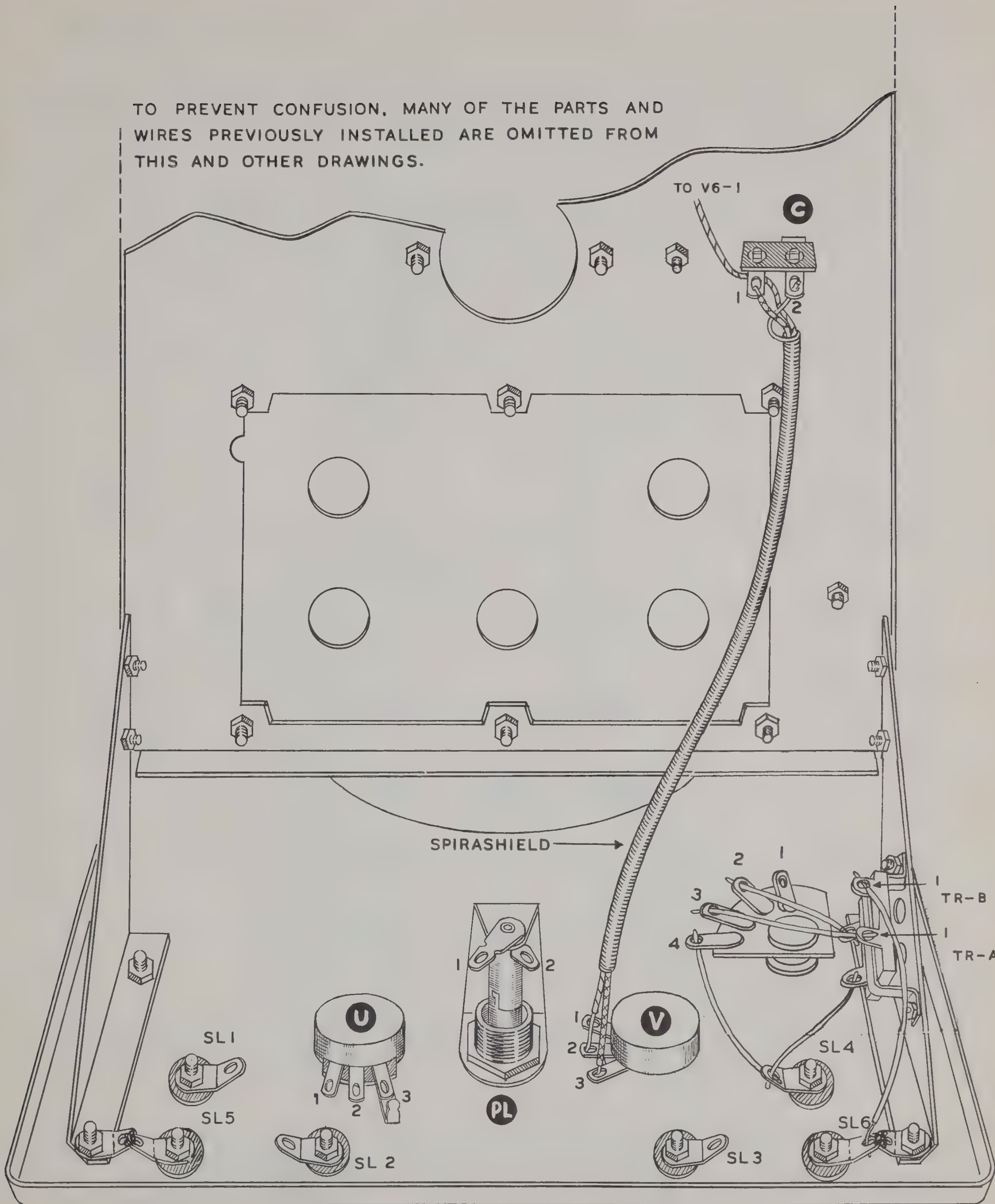
Figure 14



(✓) See Pictorial 9 and install the circuit board as follows: Insert 3-48 mounting screws into the board on the same side as the parts are mounted. On the other side, slip #3 lockwashers over each of the six screws. Now install the board on top of the chassis, making sure that the lockwashers are located between the chassis and the metal foil on the board. Tighten all six screws with 3-48 nuts.

This completes the assembly and installation of the circuit board.

(✓) Fasten the left-hand panel bracket to the panel with 6-32 binder head screws, mounting a solder lug under the nut on the lower screw, as shown in pictorial 8. (Note that the left-hand bracket has extra holes for the mounting and adjusting of the dual trimmer capacitor to be installed later.)



TO PREVENT CONFUSION, MANY OF THE PARTS AND WIRES PREVIOUSLY INSTALLED ARE OMITTED FROM THIS AND OTHER DRAWINGS.
TO V6-1
C
1
2
SPIRASHIELD
2
1
3
4
1
TR-B
1
TR-A
1
2
U
V
1
2
3
SL1
SL5
1
2
3
PL
SL 2
SL 3
SL4
SL6

PICTORIAL 8

Next assemble the following components to the dual 5-20 $\mu\mu f$ and 100-300 $\mu\mu f$ trimmer capacitor, before mounting the trimmer on the left-hand panel bracket. Refer to figure 15 for the placement of the parts.

( ) Connect across the two terminals of the 100-300 $\mu\mu f$ trimmer a 36 KΩ (orange-blue-orange) resistor. This is the trimmer without the ceramic washer under the screw head. It will be referred to as TR-B. Do not solder either connection.

( ) Connect across the same two terminals on TR-B a 390 $\mu\mu f$ mica capacitor. Do not solder either terminal.

( ) Connect a 330 KΩ (orange-orange-yellow) resistor from lug 2 on TR-B (NS) to lug 1 on TR-A (NS). TR-A is the trimmer with the ceramic washer under the screw head.

( ) Connect a 47 $\mu\mu f$ mica capacitor from lug 2 on TR-B (NS) to lug 1 on TR-A (NS).

( ) Connect one end of a 2 1/2" length of wire to lug 2 on TR-B (S).

( ) Connect a 3.3 megohm precision resistor from lug 1 on TR-A (NS) to lug 2 on TR-A (NS).

( ) Connect one end of another 2" piece of wire to lug 2 of TR-A (S).

( ) Connect one end of a 3 1/2" piece of wire to lug 1 of TR-A (S).

( ) Mount the dual trimmer assembly to the left-hand panel bracket, as shown in pictorial 8, making sure that TR-A is toward the panel.

( ) Connect the wire previously soldered to lug 2 of TR-A to SL 4 (S).

( ) Connect a wire from lug 1 on TR-B (S) to SL 6 and the ground lug adjoining it (S).

( ) Connect the wire previously soldered to lug 1 of TR-A to T3 (S).

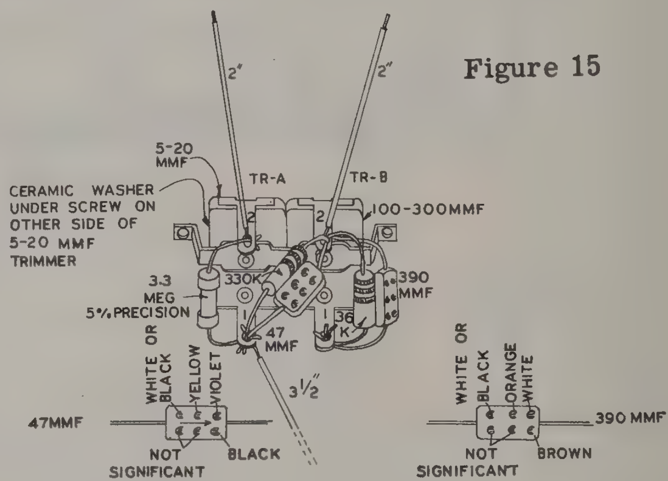
( ) Connect the wire previously soldered to lug 2 of TR-B to T2 (S).

( ) Mount the right-hand panel bracket to the front panel, using 6-32 binder head screws. Place a ground lug under the nut on the lower screw as shown in pictorial 8. Solder this lug to lug SL 5.

( ) Mount the chassis to the panel, using the left-hand and right-hand panel brackets. Use 6-32 hardware.

( ) Connect a wire from V6-2 (S) to C1 (NS).

Figure 15



( ) Connect a 1 KΩ resistor (brown-black-red) from Q3 (S) to the control solder lug at Q (S).

( ) Uncoil one end of the 6" length of spiral shielding until you have 3/4" of straight wire. Connect this wire to C2 (S).

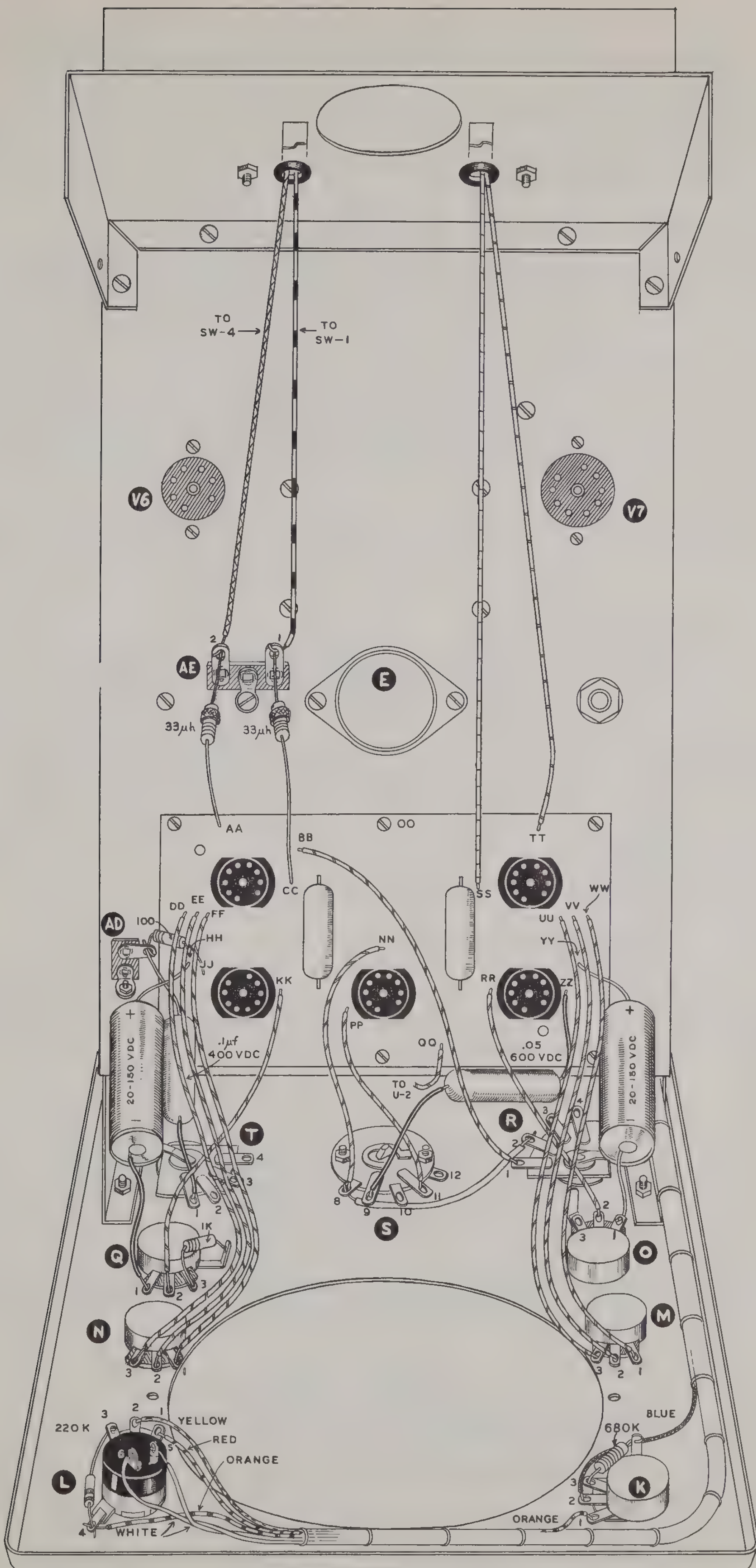
( ) Strip both ends of a 7 3/4" piece of wire. Slip the wire through the spiral shield and connect one end to C1 (S).

( ) Connect the other end to V3 (S).

( ) Strip both ends of an 11 1/2" piece of wire. Slip the wire through the spirashield and connect one end to V-2 (S). Connect the other end to V6-1 (S) and dress the wire as shown in Pictorial 8.

( ) Now turn the chassis around as in Pictorial 9 and complete the wiring of the oscilloscope. Draw the free end of the color-coded cable between the panel and chassis and then up the right edge of the panel. Dress it around the FOCUS control K and over to the INTEN. control L.

( ) Connect the yellow wire to L2 (S).


TO SW-4
TO SW-1
V6
V7
AE
E
33μh
33μh
AA
BB
OO
TT
CC
SS
DD
EE
FF
HH
JJ
AD
100
KK
NN
RR
ZZ
UU
VV
WW
YY
PP
QQ
.1μf 400VDC
.05 600VDC
20-150 VDC
TO U-2
T
R
S
Q
O
N
M
1K
220K
YELLOW
RED
ORANGE
WHITE
L
BLUE
680K
ORANGE
K

PICTORIAL 9

(✓) Connect the red wire to L1 (S).

(✓) Connect the orange wire to L4 (S).

(✓) Connect either of the white wires to L5 (S).

(✓) The remaining white wire should then be connected to L6 (S).

(✓) At the FOCUS control K, there will be two free wires coded blue and orange. Connect the orange lead to K1 (S).

(✓) Connect the blue lead to K2 (S).

(✓) Insert either lead of a .1 μfd 400 volt DC tubular capacitor into terminal lug AD (NS). Dress the condenser as shown and connect its other lead to T1 (S). Connect a 100 Ω resistor (brown-black-brown) from AD (S) to hole JJ (S) in the circuit board. Clip the excess lead at the board.

(✓) Connect a wire from S8 (NS) to the circuit board at hole NN (S). Allow enough clearance for the 12AX7 tube.

(✓) Connect a wire from S8 (S) to R2 (S).

(✓) Connect either lead of a .05 μfd 600 volt DC tubular capacitor (use sleeving) to S9 (S). Dress as shown and insert the other lead (use sleeving) in the circuit board at hole ZZ and solder.

(✓) Connect a wire from U2 (S) to the circuit board hole QQ (S). CAUTION: The printing of QQ may resemble OO. Refer to the pictorial so that no error will be made.

(✓) Connect a wire from S11 (S) to circuit board hole PP (S). (S11 is a double lug.)

(✓) Connect a wire from R1 (S) to circuit board hole BB (S).

(✓) Connect a wire from Q2 (S) to circuit board hole KK (S).

( ) Insert the positive (+) lead to a 20 μfd 150 volt DC electrolytic capacitor into the circuit board at hole HH. Dress as shown and connect the negative (-) lead to Q1 (S) (use sleeving). Now solder and clip the lead at HH.

(✓) Connect a wire from O2 (S) to circuit board hole RR (S).

(✓) Insert the positive (+) lead of a 20 μfd 150 volt DC electrolytic capacitor into circuit board hole YY. Dress as shown and wire the negative (-) lead to O1 (S). Solder and clip the lead at YY.

(✓) Cut and strip both ends of six pieces of wire, each of which should be 6 3/4" long. They are used in this, and the five following steps. Connect a wire from N3 (S) to circuit board hole DD (S).

(✓) Connect a wire from N2 (S) to circuit board hole EE (S).

(✓) Connect a wire from N1 (S) to circuit board hole FF (S).

(✓) Connect a wire from M3 (S) to circuit board hole UU (S).

(✓) Connect a wire from M2 (S) to circuit board hole VV (S).

(✓) Connect a wire from M1 (S) to circuit board hole WW (S).

NOTE: In the next steps the wire is inserted from the foil side of the board.

(✓) Connect a wire to circuit board hole GG (S). The other end of the wire should be connected to E■ (S).

(✓) Connect a wire from V6-3 (S) to hole MM (S).

(✓) Connect a lead from E- (NS) to the circuit board hole LL (S).

(✓) Connect a wire from E- (S) to V1-8 (S). See Figure 12.

(✓) Connect a lead from E▲ (S) to circuit board hole XX (S).

(✓) Connect a lead from E◓ (S) to circuit board hole OO (S).

(✓) Refer now to the two holes in the CRT support bracket directly under the "direct input bracket." Connect the wire leading from lug 1 of switch SW to AE1 (NS).

(✓) Connect the wire leading from lug 4 of switch SW to AE2 (NS).

(✓) Connect a 33 μh peaking coil from AE2 (S) to circuit board hole AA (S). Use the entire lead as shown in Figure 16. This reduces stray capacity.

(✓) Connect a 33 μh peaking coil from AE1 (S) to circuit board hole CC (S). Use the entire lead, as above.

(✓) Connect the wire leading from H3 to circuit board hole SS (S).

(✓) Connect the wire leading from G1 to circuit board hole TT (S).

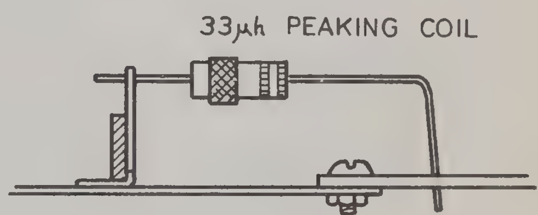


Figure 16

The wiring of your Heathkit model OM-3 Oscilloscope is now complete.

(✓) Install the 1 1/2 amp. fuse in the fuse clip at F.

(✓) Install a 1V2 tube in socket V7.

(✓) Install a 6X4 tube in socket V6.

NOTE: When installing tubes in the sockets mounted on the circuit board, do not exert a great deal of pressure straight into the socket. This could crack the board. The tubes can be inserted quite easily by rocking them back and forth a small amount while pushing into the socket gently.

(✓) Refer to the markings near each socket on the board and install each of the remaining 9-pin miniature tubes in their proper places. There should be (1) 6BA8, (1) 12AX7 and (2) 12AU7 and (1) 12BH7.

(✓) Handle the 5BP1 cathode ray tube very carefully and insert it, neck first, into the panel ring from the front. The tube neck will extend through the circular opening in the CRT support bracket. When properly installed, the center of the tube face will be recessed in the ring approximately 1/4".

(✓) Rotate the CR tube until the keyway is straight upward and then slip the CRT socket over the pins.

( ) Refer to Figure 17 and clamp the CR tube to the angle brackets mounted on the CRT support bracket. Don't forget the rubber cushion strip. The 6-32 x 1" screws are passed through the top tube clamp, the bottom tube clamp and then the angle bracket. Secure with #6 lockwashers and 6-32 nuts but do not tighten yet.

( ) Apply the printed labels to the "direct input bracket" as shown.

( ) Slip the four plain knobs (no index line) over the shafts of the following controls and tighten the set screws.

INTEN., FOCUS, VERTICAL CENTERING
HORIZONTAL CENTERING

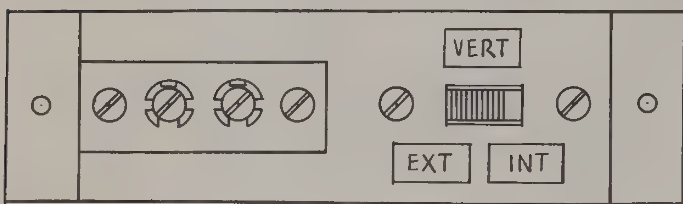


Figure 18

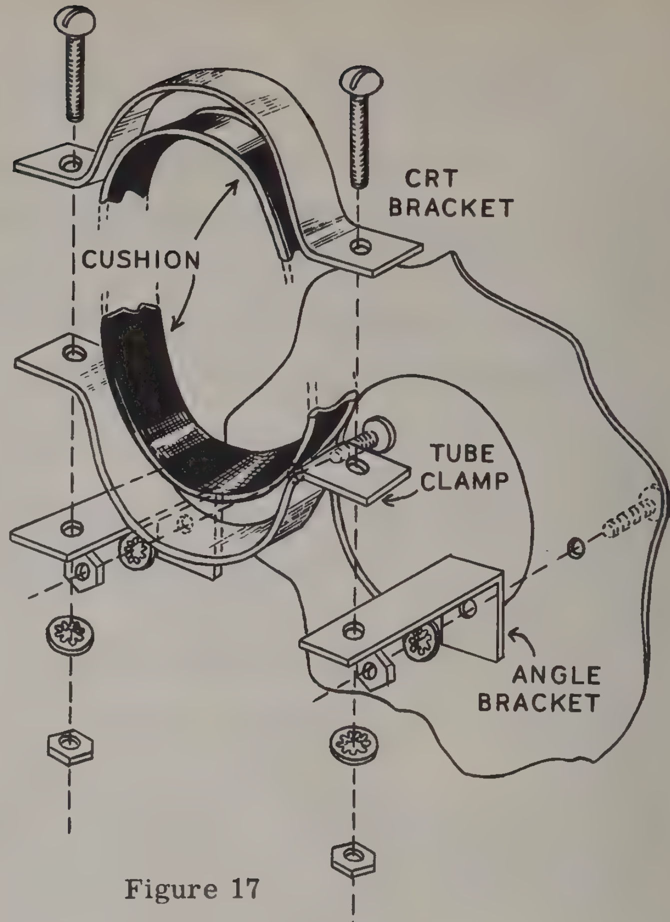


Figure 17

( ) The remaining eight shafts should now be turned completely clockwise. Pliers might be required to turn the 3-position and 6-position switches. Slip knobs over all shafts and tighten the set screws with the index lines in the following positions:

VERT. GAIN - 100	SYNC. SELECTOR - INT.
HOR. GAIN - 100	HOR. SELECTOR - Line between 20 kc and 150 kc
FREQ. VERNIER - 100	SYNC. AMPLITUDE - MAX.
VERT. INPUT - X1	PHASE - Last line in clockwise direction

( ) Screw black binding post caps on each of the two binding post bases marked "GND."

( ) Screw red binding post caps on the remaining four binding post bases.

( ) Install four rubber feet in the cabinet bottom as shown.

( ) Install the cabinet handle using #10 sheet metal screws.

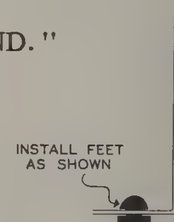


Figure 19

Before proceeding to test your oscilloscope, it is recommended that the complete assembly be checked over for proper wiring and soldering. If possible, have an acquaintance double check because an error can be continually overlooked by the kit builder while it might be readily apparent to another person.

TEST AND ADJUSTMENT

DO NOT PLUG THE LINE CORD INTO AN AC OUTLET UNTIL THE FOLLOWING PARAGRAPH IS CAREFULLY READ AND CONSIDERED.

In testing and adjusting your oscilloscope, you may be exposed to very high and dangerous voltages. Some of the highest voltages will be present at the cathode ray tube socket and at the terminals of the INTEN. and FOCUS controls located behind the top rim of the panel. Do not

attempt to rotate the CRT or move the scope on the workbench without first disconnecting the line cord from the AC outlet. It is suggested that you work with one hand behind your back and be sure that you are well insulated from all dampness through the use of rubber soled shoes or a dry wooden platform. These precautions may seem to be unnecessary to the experienced operator but you can be assured that momentary carelessness in the presence of high voltages or even the 60 cycle line voltage can easily be fatal.

(✓) Set the controls as follows before connecting the line cord to an AC outlet.

INTEN. - Full counterclockwise with AC switch OFF.
FOCUS - Approximate center of rotation.
VERTICAL CENTERING - Approximate center of rotation.
HORIZONTAL CENTERING - Approximate center of rotation.
VERT. GAIN - Full counterclockwise.
FREQ. VERNIER - 50
HOR. GAIN - 0
VERT. INPUT - X100
HOR. SELECTOR - HOR. INPUT
SYNC. SELECTOR - INT.
PHASE - Approximate center of rotation.
SYNC. AMPLITUDE - Approximate center of rotation.
Astigmatism (on chassis) - Approximate center of rotation.

(✓) Connect the line cord to a 105-125 volt 50-60 cycle AC outlet. CAUTION: This instrument will not operate and may be seriously damaged if connected to a DC or 25 cycle AC power source or to an AC line of more than 125 volts.

(✓) Turn the INTEN. control fully clockwise. This will apply power to the circuit and all tubes except the 1V2 should begin to glow. This tube uses a filament voltage of less than 1 volt and a glow will be very difficult to detect. Allow at least one minute as a warm-up period.

(✓) As soon as a green spot appears on the face of the CR tube, reduce the intensity by rotating the INTEN. control counterclockwise. CAUTION: Do not allow a high intensity spot to remain stationary on the CRT because it can damage the fluorescent material and leave a dark spot. If no spot appears, rotate the VERTICAL and HORIZONTAL CENTERING controls simultaneously since these controls might position the spot well off the tube face. It might also be necessary to readjust the FOCUS and INTEN. controls to form a spot. Should you be unable to locate a spot at all, there is a chance that an assembly error has been made. In that case, recheck wiring and refer to the IN CASE OF DIFFICULTY section of the manual.

(✓) With the intensity reduced, adjust the FOCUS control for minimum spot size. There will be normal interaction between the FOCUS and INTEN. controls and by alternately adjusting each one, you can obtain a small spot of any desired intensity.

(✓) Center the spot in the CRT face by adjusting its vertical location with the VERTICAL CENTERING control and its horizontal location by means of the HORIZONTAL CENTERING control. Their functions are to permit centering only and not necessarily to deflect the spot off the tube face in all directions.

(✓) Now adjust the astigmatism control on the chassis to obtain a perfectly round spot. This control will react similarly to the FOCUS control and it might be necessary to readjust both as well as the INTEN. control to obtain a sharply defined spot. Once adjusted, however, it will be permanent unless there is a future change in the instrument's characteristics.

(✓) Connect a jumper wire between the 1 V. P-P and the HOR. INPUT posts. Turn the HOR. GAIN control clockwise and notice that the spot becomes a horizontal line, whose length increases as more horizontal gain is used. If the trace is not perfectly horizontal, indicate

its slope with a crayon or wax pencil on the CR tube. Pull the line cord out of the AC outlet and then rotate the CR tube until the marking is level. Tighten the tube clamps and then plug the scope in again.

( ) Return the HOR. GAIN control to 0 and then disconnect the jumper from the HOR. INPUT post. Connect the jumper to the VERT. INPUT post and rotate the VERT. GAIN control clockwise. The spot will elongate vertically somewhat as the control is turned the maximum amount. A line may not appear distinctly because of the very low voltage signal input.

( ) Without touching the other controls, turn the VERT. INPUT switch to the X10 position. The spot should become a short line. Turn the switch to the X1 position and the line will extend vertically about three-fourths of the way across the tube face.

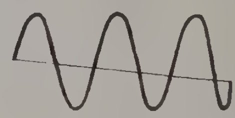


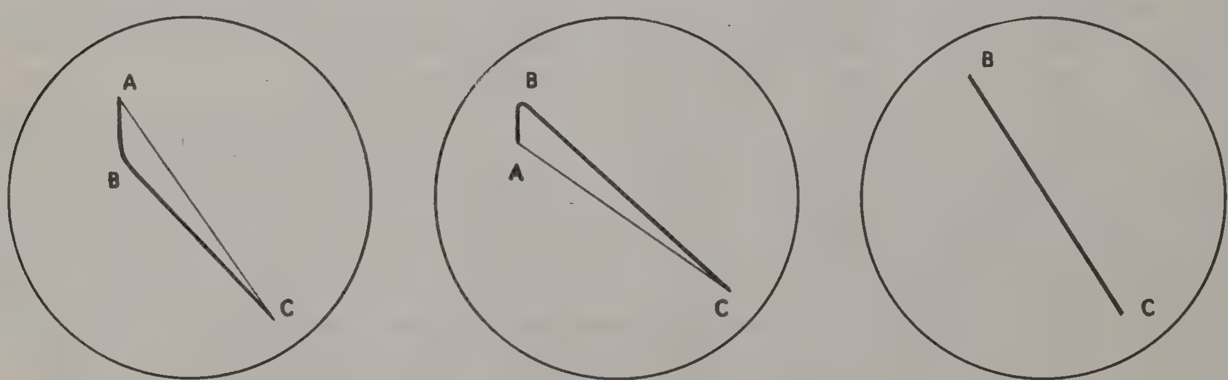
Figure 20

( ) Set the HOR. SELECTOR switch to the line between 20 and 120. Reduce VERT. GAIN for a pattern height of about 1". Adjust the HOR. GAIN control for a pattern width of about 2". Now slowly adjust the FREQ. VERNIER control to obtain a pattern consisting of three complete sine waves as in Figure 20. Stabilize the pattern by rotating the SYNC. AMPLITUDE control clockwise. A definite flickering will be noticed because the horizontal sweep frequency of 60/3 or 20 cycles per second is slow enough for the eye to detect. There may also be a random movement of the complete pattern due to slight variations in line voltage.

( ) To test the PHASE control, set the HOR. SELECTOR switch to the 60 CY. position and adjust VERT. and HOR. GAIN for equal height and width. The pattern should be roughly a circle. By rotating the PHASE control from one extreme to the other, the pattern will change from a slanting line to a circle and then to an ellipse slanting in the opposite direction.

( ) Pull the line cord out of the AC outlet. Disconnect the jumper between 1 V. P-P and VERT. INPUT. Connect a jumper from VERT. INPUT to the center lug of the HOR. GAIN control behind the panel. Plug the line cord in again and set the HOR. SELECTOR switch to the line between 120 and 1400. Set the FREQ. VERNIER control to 0 and the VERT. GAIN control to 100. Set the VERT. INPUT switch to X10 and adjust HOR. GAIN until the pattern resembles Figure 21A or B. Now adjust trimmer TR-A (the trimmer toward the front panel) until the A-B leg of the triangle disappears as in figure 21-C.

( ) Move the VERT. INPUT switch to the X100 position and adjust trimmer TR-B in the same manner. Notice that this pattern will be almost horizontal and the AB leg of the triangle is much shorter.



A — TRIMMER CAPACITY HIGH

B — TRIMMER CAPACITY LOW

C — TRIMMER ADJUSTED PROPERLY

Figure 21

If all controls and switches react normally and the tests are successful, the oscilloscope can be installed in the cabinet.

(✓) Pass the line cord through the circular opening in the rear of the cabinet and slide the instrument in. The panel should fit snugly around the front rim. Fasten by means of two #6 sheet metal screws inserted through the rear of the cabinet into the large chassis skirt.

(✓) Insert another screw through the cover plate at the rear of the cabinet to hold it in place.

DO ( ) Carefully trim the green plastic grid screen to size so that it fits snugly within the felt lined panel ring. Insert the screen so that it rests against the face of the CR tube.

This completes the construction and adjustment of your Heathkit model OM-3 Oscilloscope.

IN CASE OF DIFFICULTY

① MISTAK

If the testing procedure described does not produce the expected results, the following is recommended:

1. Check the wiring against the pictorial diagrams and closely inspect each soldered terminal. Locate each component wired to the circuit board and check their positions and values with the pictorials. If possible, have an acquaintance double check your work.

2. Check the voltages at the tube socket terminals. The readings should compare within 25% with those listed in the voltage chart. These measurements were made with a Heathkit VTVM with an input resistance of 11 megohms. Voltages may vary greatly when taken with instruments having other input characteristics. Should a serious voltage discrepancy show up, carefully check the components associated with that tube.

3. Check the tubes or have them checked at a reputable service establishment. If possible, use substitute tubes of known quality for comparison because certain types of tube defects do not show up clearly in any but laboratory tube testers.

4. If the difficulty seems to be of an intermittent nature, depending upon the physical movement of the circuit board, the metal circuit pattern should be inspected for breaks. These breaks can occur if the board has been severly bent or accidentally dropped. A broken metallic strip can easily be repaired in the following manner: Lay a piece of bare hookup wire along the strip and shape it to the original strip contours. Now solder the wire to the strip a short distance on each side of the break.

5. Should the procedure as outlined fail to correct your difficulty, write to the Heath Company describing the nature of the trouble by giving all possible details, including voltage readings obtained and other indications you may have noticed. We will attempt to analyze your trouble and advise you accordingly. No charge is made for this service. In all correspondence, refer to this instrument as the model OM-3 Oscilloscope.

Note: Several of the 2 watt resistors in this instrument may become quite hot after extended operation. This is a normal condition and is no cause for alarm.

VOLTAGE CHART

NOTE: Set all knobs as instructed for testing on Page 27, with the following exceptions:

1. Do not readjust the astigmatism control.
2. Rotate INTEN. control clockwise <u>only</u> until the switch clicks.

SOCKET TUBE TYPE	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8	Pin 9
V1 6BA8	150	NS	325	0	H	4.5	NS	170	220
V2 12BH7	260	15	25	H	H	260	15	25	0
V3 12AX7	140	NS	0	H	H	170	140	140	0
V4 12AU7	280	NS	140	H	H	150	NS	6.6	0
V5 12AU7	250	11.5	24	H	H	250	11.5	24	0
V6 6X4	375 AC	NS	H	0	NC	375 AC	400		
V7 1V2	NC	NC	NC	1025 AC	1025 AC	NC	NC	NC	-1120
V8 5BP1 CRT	-1030	NC	250	-700	NC	260	255	250	260
	Pin 10	Pin 11							
	-1060	-1030							

NS - not significant to testing.
H - heater terminal, 5.7 volt to 6.3 volt AC.
NC - no connection.
Line Voltage - 115 volts at 60 cps.
No signal input
Voltage should be within ±20% of those noted above.
All voltages +DC except as noted. All voltages measured to chassis ground.

CIRCUIT DESCRIPTION

The cathode ray tube consists of:

1. <u>Electron Gun;</u> which shoots a stream of electrons toward the face of the tube which is coated with a fluorescent material. This causes the tube screen to light up wherever the electrons strike.
2. <u>Control Grid;</u> which controls the number of electrons that strike the tube and consequently the brightness of the trace. The potential on this tube element is set up by the operator by means of the INTEN. control.
3. <u>Focusing Anode;</u> which has the ability to converge the electron stream into a single beam of variable diameter. The FOCUS control makes it possible to reduce the size of the beam and obtain a very small spot on the tube face.
4. <u>Accelerating Anode;</u> which operates in conjunction with the focusing anode and speeds the electrons on their way. The potential at this element is set by means of the astigmatism control, which affects the shape rather than the size of the spot.

5. Two Vertical Deflection Plates; which are set at right angles to the direction of flow of electrons. The potential difference between the plates will bend the beam either up or down. A DC difference is set up for centering purposes by means of the VERTICAL CENTERING control.
6. Two Horizontal Deflection Plates; which operate in the same manner as the vertical plates except that their effect on the electron beam is in the horizontal direction. The HORIZONTAL CENTERING control provides the necessary centering adjustment.

To increase the overall sensitivity of the instrument, both horizontal and vertical amplifiers are used. This makes it possible to observe clearly the waveforms of voltages of very small amplitudes. For applications such as the checking of modulation percentage of an RF carrier, where the frequency response of the vertical amplifiers is inadequate, direct connection to the vertical deflection plates of the CRT are available.

A linear time base is provided by the internal sweep generator which produces a sawtooth type voltage of variable frequency. This voltage, when applied to the horizontal deflection plates, causes the spot to move at a fixed rate across the tube face from left to right. It then returns quickly to the left side to begin the next sweep. Any voltage applied to the vertical deflection plates will cause the beam to be displaced vertically at the same time. Thus the actual waveform is displayed in addition to a comparison between its repetition rate and time.

Provisions are also made so that an externally generated sweep voltage or an AC voltage at line frequency can be used in place of the built-in sweep generator.

OPERATION OF THE OSCILLOSCOPE

The operation of an oscilloscope and its many controls is quite simple once the basic principles are clear. The controls can be divided into groups with specific functions.

Two knobs marked INTEN. and FOCUS and the astigmatism control located on the chassis, control the quality of the trace. Disregarding normal interaction, the INTEN. knob adjusts brightness and the FOCUS knob the sharpness of the trace on the oscilloscope screen. The astigmatism control is permanently set by the operator for the ideal spot shape. A perfectly round spot will permit sharp focusing regardless of the direction of movement of the electron beam.

Two knobs marked VERTICAL CENTERING and HORIZONTAL CENTERING control the location of the trace on the screen. Turning the vertical knob shifts the trace up and down and the horizontal knob moves the trace left or right.

Two knobs marked VERT. INPUT and VERT. GAIN control the height of the pattern. The 3-position vertical input attenuator switch adjusts the vertical sensitivity of the oscilloscope in step functions. Fine adjustment of vertical sensitivity is made with the vertical gain control.

An end limit resistor is incorporated in the vertical gain control circuit which prevents reducing the pattern height to zero. Because of this, the operator will be aware of improper adjustment of the VERT. INPUT switch when the pattern height exceeds the screen diameter with the VERT. GAIN control set at minimum. Distortion of the wave-shape caused by overloading of the input cathode follower may be avoided by proper use of this feature. A 10:1 ratio of vertical gain is provided by the values used.

One knob marked HOR. GAIN controls the width of the pattern.

Two knobs marked FREQ. VERNIER and HOR. SELECTOR provide the choice and the control over the sweep voltage to be applied to the horizontal deflection plates of the CRT. The maximum counterclockwise position of the horizontal frequency selector switch connects the input of the horizontal amplifiers to the HOR. INPUT binding post. This makes it possible to use an external source for the horizontal sweep voltage. The next position of the switch applies a 60 cycle sinusoidal voltage from the low voltage secondary winding of the power transformer to the input of the horizontal amplifiers, thus providing a sweep at line frequency. All other positions of the

switch represent a choice, in step functions, of the frequencies available from the sawtooth sweep generator. A fine control over these frequencies is provided in the FREQ. VERNIER control.

One knob marked PHASE, controls the phase relationship between the 60 cycle line sweep voltage and any voltage that might be applied to the VERT. INPUT binding post. Its purpose is to compensate for any undesirable phase shift in the signal that you wish to observe.

Two knobs marked SYNC. SELECTOR and SYNC. AMPLITUDE provide the stabilizing action needed to keep the pattern from drifting to the left or right. With the SYNC. SELECTOR switch you can choose between (a) a synchronizing voltage taken from the signal applied to the vertical amplifiers; (b) a 60 cycle AC voltage taken from the filament winding of the power transformer and (c) any desirable synchronizing voltage that may be applied to the EXT. SYNC. binding post. In all cases, the amplitude of the required voltage is controlled by the SYNC. AMPLITUDE control.

Since each AC pattern observed on an oscilloscope will represent a peak-to-peak value, it is desirable to calibrate the grid screen so that these voltages can be accurately measured. A 1 volt peak-to-peak calibration voltage is available at the 1 V. P-P binding post. The exact value of the calibration voltage is based on a filament supply of 6.3 volts which in turn depends upon the line voltage in a given area. Further variation from 1 volt peak-to-peak may occur due to the normal tolerances allowed in the voltage divider resistance values. Knowing all of these variables, any one oscilloscope can be accurately adjusted to measure peak-to-peak voltages with good accuracy.

In order to couple a signal directly to the vertical plates of the CRT, the DPDT switch at the rear of the oscilloscope must be moved to the EXT. position. The signal is then applied across the terminals of the 2-screw strip located next to the switch. Polarity is not important because neither of the vertical deflection plates are grounded within the scope itself. The sensitivity of the cathode ray tube and the amplitude of the applied signal will determine the height of the pattern.

For the safety of the operator, B+ potential is blocked from the 2-screw terminal strip by the two .005 μfd disc type condensers. They also serve to maintain the use of the VERTICAL CENTERING control by preventing the virtual shorting of the vertical deflection plates through a low impedance signal source. The VERT. GAIN control however, will have no effect. In all oscilloscope applications requiring the use of vertical amplifiers, the DPDT switch should be in the INT. position.

REPLACEMENTS

Material supplied with Heathkits has been carefully selected to meet design requirements and ordinarily will fulfill its function without difficulty. Occasionally improper instrument operation can be traced to a faulty tube or component. Should inspection reveal the necessity for replacement, write to the Heath Company and supply all of the following information:

A. Thoroughly identify the part in question by using the part number and description found in the manual parts list.
B. Identify the type and model number of kit in which it is used.
C. Mention the order number and date of purchase.
D. Describe the nature of defect or reason for requesting replacement.

The Heath Company will promptly supply the necessary replacement. Please do not return the original component until specifically requested to do so. Do not dismantle the component in question as this will void the guarantee. If tubes are to be returned, pack them carefully to prevent breakage in shipment as broken tubes are not eligible for replacement. This replacement policy does not cover the free replacement of parts that may have been broken or damaged through carelessness on the part of the kit builder.

If the circuit board has been accidentally damaged through breakage, the excessive use of solder, through the use of acid or paste fluxes or for any other reason, a complete repair kit is available. The Heathkit Repair Kit R-OM3 for the OM-3 Oscilloscope will consist of etched circuit board and all sockets, resistors and condensers to be mounted directly on the board itself. The price is $5.00 plus postage. A replacement for the horizontal selector switch is available as a separate item for $.75 plus postage.

SERVICE

If, after applying the information contained in this manual and your best efforts on the unit, you are still unable to obtain proper performance from the Oscilloscope, it is suggested that you take advantage of the technical facilities which the Heath Company makes available to its customers.

The Technical Consultation Department is maintained for the purpose of providing Heath customers with a personalized technical consultation service; this service is available to you without charge. The technical consultants are thoroughly familiar with all details of the Oscilloscope and can usually localize the trouble from a suitable description of the difficulty encountered. It is, of course, necessary that you provide full and complete information concerning your problem when writing to the Technical Consultation Department for assistance. For instance, clearly identify the kit involved, giving the purchase date and, if possible, the invoice number; describe in detail the difficulty that you have encountered; state what you have attempted to do to rectify the trouble, what results have been achieved, and include any information or clues that you feel could possibly be of value to the consultant who handles your problem. Failure to provide complete descriptive details may lead to incorrect assumptions on the part of the consultant and needless delay in the solution to your problem. Quite frequently, when the information given the consultant is complete, concise and reliable, a diagnosis of the difficulty can be made with confidence and specific instructions given for its correction. If replacement of a component is involved in the correction, the component will be shipped to you, subject to the terms and conditions of the Warranty.

The Factory Service facilities are also available to you, in case you are not familiar enough with electronics to provide our consultants with sufficient information on which to base a diagnosis of your difficulty, or in the event that you prefer to have the difficulty corrected in this manner. You may return the completed Oscilloscope to the Heath Company for inspection and necessary repairs and adjustments. You will be charged a fixed fee of $6.00, plus the price of any additional parts or material required. However, if the Oscilloscope is returned within the Warranty period, parts charges will be governed by the terms of the Warranty. State the date of purchase and give invoice number, if possible.

Local Service by Authorized Heathkit Dealers is also available and often will be your fastest, most efficient method of obtaining service for your Heathkits. Although you may find charges for local service somewhat higher than those listed in Heathkit manuals (for factory service), the amount of increase is usually offset by the transportation charges you will pay if you elect to return your kit to the Heath Company.

Heathkit dealers will honor the regular 90 day Heathkit Parts Warranty on all kits, whether purchased through a dealer or directly from Heath Company. It will be necessary that you verify the purchase date of your kit by presenting your copy of the Heath Company invoice to the authorized dealer involved.

Under the conditions specified in the Warranty, replacement parts are supplied without charge; however, if your local dealer assists you in locating a defective part (or parts) in your Heathkit, or installs a replacement part for you, he may charge you for this service.

Heathkits purchased locally and returned to Heath Company for service must be accompanied by your copy of the dated sales receipt from your authorized Heathkit dealer in order to be eligible for parts replacement under the terms of the Warranty.

THESE SERVICE POLICIES APPLY ONLY TO COMPLETED INSTRUMENTS CONSTRUCTED IN ACCORDANCE WITH THE INSTRUCTIONS AS STATED IN THE MANUAL. Instruments that are not entirely completed or instruments that are modified in design will not be accepted for repair. Instruments showing evidence of acid core solder or paste fluxes will be returned NOT repaired.

For information regarding modifications of Heathkits for special applications, it is suggested that you refer to any one or more of the many publications that are available on all phases of electronics. They can be obtained at or through your local library, as well as at most electronic outlet stores. Although the Heath Company welcomes all comments and suggestions, it would be impossible to design, test, evaluate and assume responsibility for proposed circuit changes for specific purposes. Therefore, such modifications must be made at the discretion of the kit builder, according to information which will be much more readily available from some local source.

SHIPPING INSTRUCTIONS

Before returning a unit for service, be sure that all parts are securely mounted.

ATTACH A TAG TO THE INSTRUMENT GIVING NAME, ADDRESS AND TROUBLE EXPERIENCED.

Pack in a rugged container, preferably wood, using at least three inches of shredded newspaper or excelsior on all sides. DO NOT SHIP IN THE ORIGINAL KIT CARTON AS THIS CARTON IS NOT CONSIDERED ADEQUATE FOR SAFE SHIPMENT OF THE COMPLETED INSTRUMENT. Ship by prepaid express if possible. Return shipment will be made by express collect. Note that a carrier cannot be held liable for damage in transit if packing, in HIS OPINION, is insufficient.

SPECIFICATION CHANGES

All prices are subject to change without notice. The Heath Company reserves the right to discontinue instruments and to change specifications at any time without incurring any obligation to incorporate new features in instruments previously sold.

BIBLIOGRAPHY

While many issues of the popular radio and service magazines have carried excellent articles on the construction and application of oscilloscopes and their reading is highly recommended, we also suggest the following excellent books:

Ruiter; Modern Osciloscopes and Their Uses
Hickok; How to Use the CR Oscilloscope in Servicing Radio and TV
Rider; The Cathode Ray Tube at Work
Turner; Radio Test Instruments
Editors and Engineers; Radio Handbook
A. R. R. L.; Radio Amateurs' Handbook
Rider and Uslan; Encyclopedia on Cathode Ray Oscilloscopes and Their Uses

SOME OSCILLOSCOPE APPLICATIONS

As mentioned in the introduction to this manual, the cathode ray oscilloscope is a most versatile device. It has the ability to measure the basic electrical quantities and more important, to show the relationship between any two of these quantities at any one time. Or, it can relate any one of the variables against a controlled time reference. Therefore, it can indicate such characteristics as frequency, phase relations and waveform.

By use of supplementary devices called transducers, a great variety of other physical attributes can be investigated with the oscilloscope. These transducers are used to convert sound, heat, light, stress or physical movement into electrical impulses. The impulses can be studied by displaying them on the screen of the oscilloscope.

The following portion of this manual is simply to familiarize you with the basic applications of your oscilloscope. Each one of the uses described is well within the capabilities of the Heathkit model OM-3 Oscilloscope.

Waveform Investigation: Probably the major use of most oscilloscopes is in the study of recurrent or transient variations in an electrical quantity. Since the oscilloscope is a voltage operated device, these variations must be first converted into changes in voltage.

It is common practice to apply the signal voltage to the vertical input to the oscilloscope. By the use of amplifiers, this voltage is made to displace vertically the electron beam in the cathode ray tube. At the same time, the beam is being swept horizontally by the sweep generator within the instrument. The sweep frequency is normally a sub-harmonic or simple fraction of the signal frequency. Therefore, more than one complete cycle of the signal is shown in the screen.

With this brief background, we have described below the more common applications of the oscilloscope in studying waveform.

Testing Audio Amplifiers and Circuits: Figure 22 shows the conventional set-up of equipment for this application. The audio generator should be capable of producing a pure sine wave with a very low harmonic distortion. The load resistor should match the output impedance of the amplifier. The usual practice is to perform all tests at an input voltage sufficient only to develop a reference power output. This prevents overloading of any portion of the amplifier and consequent inaccuracies in measurements.

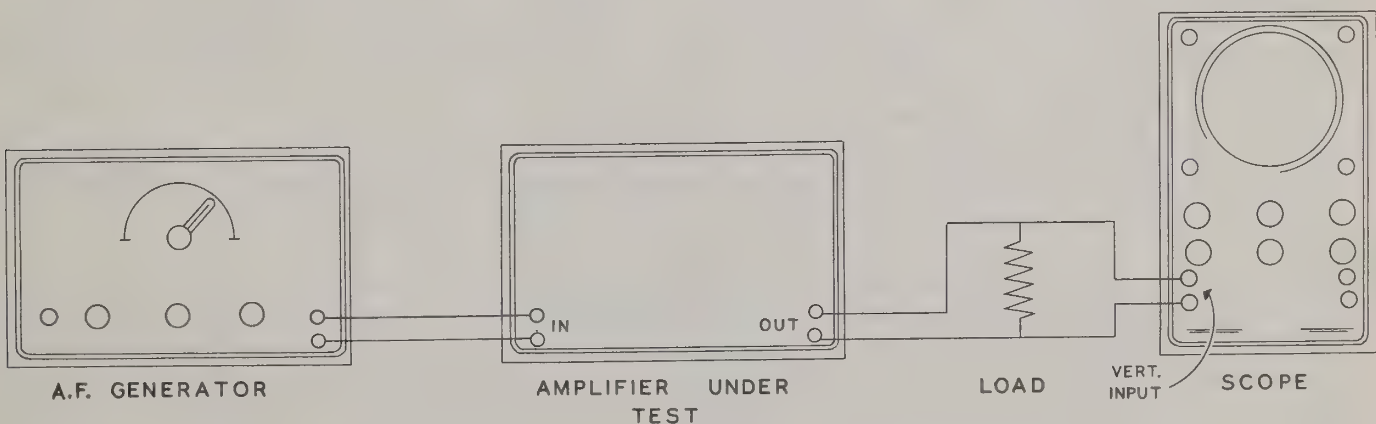


Figure 22

Figure 23A shows serious flattening of one peak representing about 10% harmonic distortion. This condition may be caused by incorrect bias on any stage or by an inoperative tube in a push-pull stage. Figure 23B indicates third harmonic distortion, a particularly objectionable fault. Figure 23C shows flattening of both peaks, usually an indication of overload somewhere in the circuit.

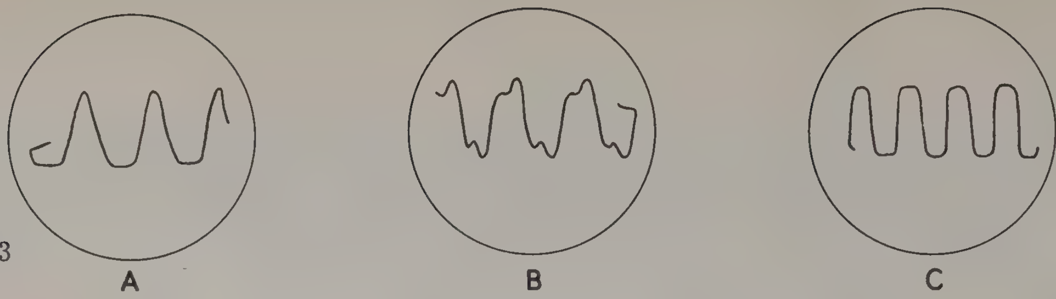


Figure 23

Although the use of sine wave input tells us a lot about an amplifier, the use of a square wave input waveform gives a very accurate and extremely sensitive indication of the performance of the system with respect to both amplitude distortion and phase shift. Assume that we apply a wave of the form shown in Figure 24A with a fundamental frequency of 60 cycles. In a theoretically perfect amplifier, the output waveform would be an exact duplicate except at a greater power level as determined by the gain of the amplifier. Actually, the distortion of this waveform as shown in the scope tells a great deal about the amplifier at frequencies considerably separated from the test frequency. If the high frequency performance of the amplifier is excellent, the front of the waveform will be sharp cornered and clean.

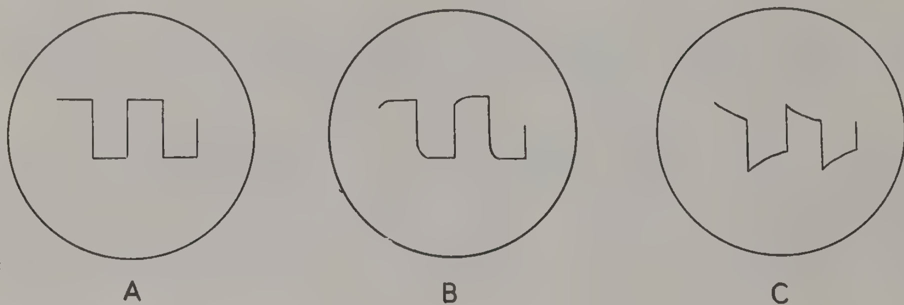


Figure 24

A distortion similar to that shown in Figure 24B indicates a poor high frequency response, which may be amplitude distortion, phase shift, or both. We may assume therefore, that the shape of the rising portion of the waveform indicates the ability of the amplifier to faithfully reproduce high frequencies. Conversely, the slope of the flat top portion of the wave, indicates the performance of the amplifier in the low frequency range. Figure 24C is the characteristic indication of an amplifier with a poor low frequency response.

Again, the square wave generator used must be capable of producing the desired waveform with excellent voltage regulation and low inherent distortion. The Heathkit model AO-1 Audio Oscillator is recommended.

Further discussion of this method is beyond the scope of this manual. Interested readers are referred to the bibliography for further sources.

Servicing Television Receivers: Servicing of television receivers is a rapidly expanding application of the cathode ray oscilloscope. Each of the following basic uses require some additional equipment, but none of them can be performed without using the oscilloscope.

Alignment of a television receiver is virtually impossible without the use of an oscilloscope and a television alignment sweep generator such as the Heathkit TS series. This type of generator supplies an RF signal over all the frequencies involved in modern television receiver operation. The signal can be frequency modulated at 60 cycles per second with a deviation of several megacycles. The generator also provides a 60 cycle sweep voltage controllable in phase to drive the horizontal deflection amplifiers in the oscilloscope. It also provides a blanking system which cuts off the RF output of the generator during one-half of its operating cycle. In effect, the generator output starts at a reference frequency and sweeps alternately at a uniform rate from referance frequency to frequencies several megacycles above and below. Vertical input to the scope is driven by voltage developed at the input of the video amplifier. Since this voltage varies in exact accordance with the gain of the RF and/or IF amplifier stages over the frequency range being swept, the trace on the screen is actually a graphic representation of the response of the amplifiers being tested.

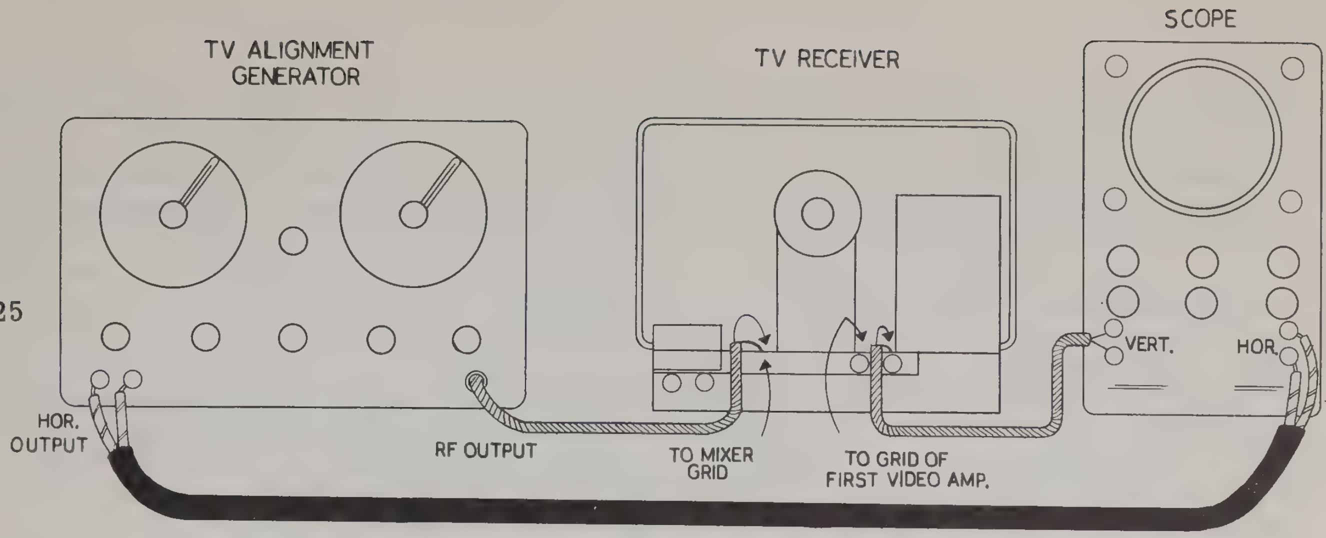


Figure 25

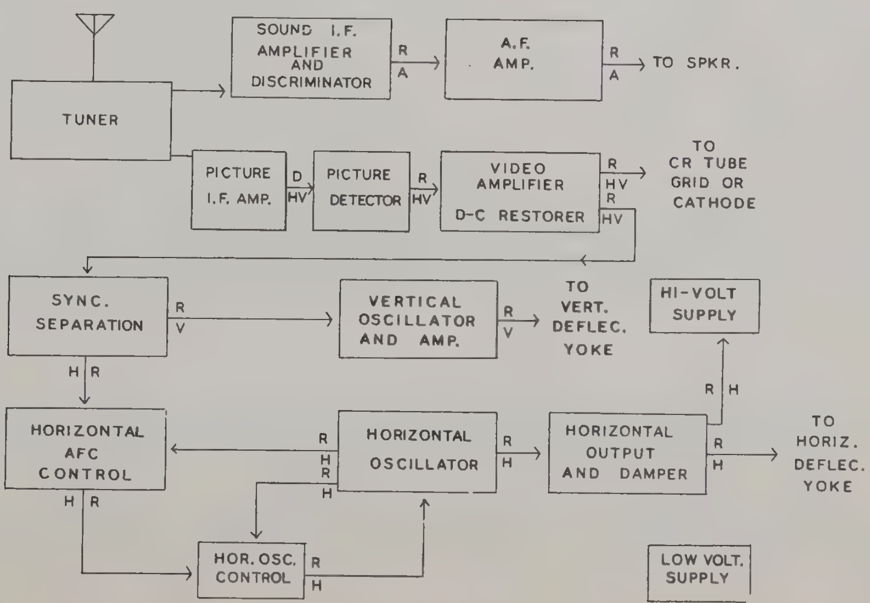
Figure 25 outlines the connections between alignment generator, receiver and oscilloscope. The exact procedure for alignment varies greatly. This information is generally available in the manufacturers' service information. Usually a drawing of the desired response curve is given together with a sequence of adjustments to roughly approach the desired pattern. Final adjustments are made while watching the trace on the oscilloscope.

The waveform of the complex television picture signal as it is passed through the receiver is undoubtedly the most important characteristic of the signal voltage. In order to properly display the minute variations in waveform which incidentally make up the difference between good and bad picture quality, the oscilloscope is required to amplify and display voltage changes over an extremely wide frequency range without distorting them.

Again, you must rely on the manufacturer to furnish representative patterns showing the waveform to be expected at specific points within the receiver. You will find that these diagrams cover the entire receiver with the exception of the front end or tuner portion. However, in order to pick off the modulation envelope in the IF or video amplifier sections, a demodulator probe is used to make connections to the plate, grid or cathode of the stage being investigated. This is necessary since the signal in these stages is still contained in the amplitude modulation envelope of the carrier and must be detected or demodulated before it can be shown on the oscilloscope.

The Heathkit Demodulator Probe is designed for this purpose. At any point after the video detector, no such probe is necessary and a simple shielded low capacity cable can be used.

Figure 26



OPERATE OSCILLOSCOPE AS SHOWN BELOW:

R Use direct input.
D Use demodulated input.
H Use 7,875 or 15,750 cps sweep.
V Use 20, 30 or 60 cps sweep.
A Use audio test frequency sweep or half this frequency.

NOTE: For simplicity, all amplifier stages are shown within one block in the diagram. Tests may be made at the input or output of individual amplifier stages using the indicated mode of operation.

In either case, the signal voltage is fed into the vertical amplifier of the oscilloscope as shown in Figure 26. At any point up the video detector, the voltages picked off will be quite small and considerable vertical gain will be required. Within the sync circuits and deflection circuits, however, these voltages reach very respectable proportions and very little amplification is required.

In checking waveform, remember that two basic frequencies are involved in the television signal. The vertical or field frequency is 60 cycles per second. Any investigation of the circuit except within the horizontal oscillator, its differentiator network and the horizontal amplifier stages can generally be made using a sweep generator frequency of 20 or 30 cycles, thus showing two or three complete fields of the signal. In order to study the horizontal pulse shape or the operation of the horizontal deflection system, it is generally necessary to operate the sweep generator at 15,750 or 7,875 cycles per second. This sweep rate will show the waveform of one or two complete lines of the signal.

The signal tracing method of analysis is most helpful in going through a receiver in this fashion, since faulty receiver operation is generally caused by the loss of all or a significant portion of the picture information and pulses at some stage within the receiver. With a basic understanding of the function of each part of the signal and with the means available to determine what the signal actually looks like at any part of this receiver, it is a comparatively simple matter to isolate the defective portion and the particular component causing the failure.

Remember in making connections to the test points that grid circuits are generally high impedance points and that the addition of any capacity can disrupt the performance of the stage to some degree. Plate circuits and cathode circuits are usually lower impedance points and more desirable for testing purposes. Also bear in mind that the plate circuit indication with respect to polarity will be exactly opposite to indications obtained on grid or cathode, since a phase difference of 180° takes place within the tube. Therefore, the pattern shown on the scope screen may be inverted when such interchanges are made. The form of the wave will not be changed however.

Video amplifier response can be measured in exactly the same manner described for testing audio amplifiers and again a square wave signal is the most efficient method to use. Because a video amplifier must pass signals as low as 20 cycles and as high as 4 or 5 megacycles, a more comprehensive test is required. Usually a 60 cycle check is made to cover low and medium frequency characteristics. A second check at 25 kc covers the high frequency portion of the response curve. Again such tests require accuracy on the part of the oscilloscope. The signal tracing technique can be used in these tests also. The square wave generator is fed directly into the first video amplifier grid. Very low signal input will be required. Then the oscilloscope is connected to various plates starting near the output end and working back until any distortion is isolated. Patterns such as Figure 24B are responsible for poor picture detail or fuzziness, while distortion of the waveform shown in Figure 24C can cause shading of the picture from top to bottom.

Observing Modulation Patterns: Amateur radio operators often use the oscilloscope to check the quality of modulated RF signals obtained from their transmitters. Since the vertical amplifier frequency response of the oscilloscope is not adequate to accurately reproduce the frequencies of the RF carrier, except on 160 and 80 meters, direct connections to the vertical deflection plates of the cathode ray tube are required. These connections are available at the rear of the Heathkit OM-3 Oscilloscope.

When using the oscilloscope for this purpose, the operator generally relies on the trapezoidal pattern for test purposes. Such a pattern is formed when a modified RF signal is applied to the vertical deflection plates of the cathode ray tube and the modulating audio signal used for horizontal deflection. This modulating signal can be applied to the horizontal input terminals of the oscilloscope.

The appearance of a typical trapezoidal pattern is given in Figure 27A. As the modulation percentage increases, the pattern becomes more triangular in shape, approaching a perfect triangle with 100% modulation as shown in Figure 27B. Over modulation gives patterns shown in Figure 27C.

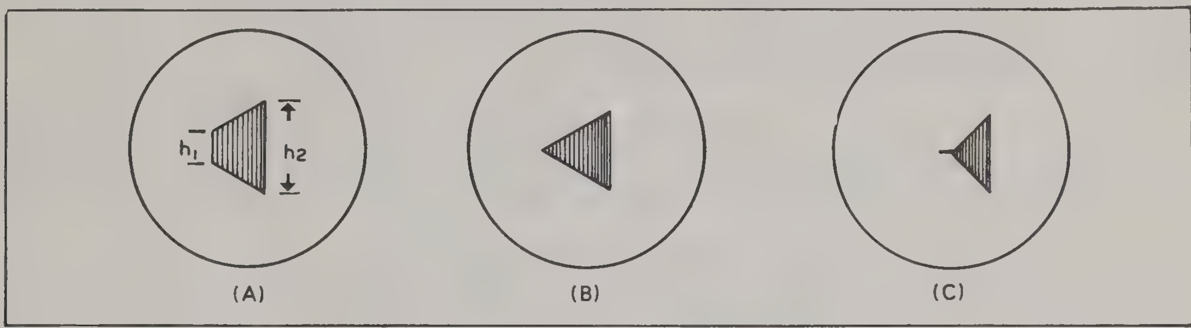


Figure 27

A trapezoidal pattern is useful for determining percentage modulation. The maximum (h2) and minimum (h1) heights of the trapezoid are measured using any convenient unit. Percentage of modulation may then be calculated as follows:

$$\frac{(h2 - h1)}{(h2 + h1)} \times 100 = \text{Percentage modulation}$$

Trapezoidal patterns are also useful for indicating the operational characteristics of RF signals obtained from carrier current transmitters, phono oscillators and similar devices. Typical patterns that may be obtained are shown in Figure 28.

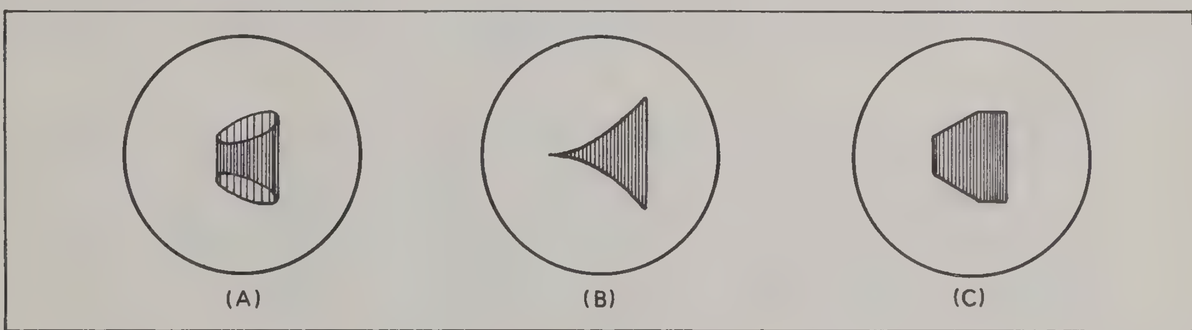


Figure 28

Figure 28A shows the type of pattern obtained with less than 100% modulation, but with phase shift in the audio signal between the point at which the audio signal is taken for the oscilloscope horizontal deflection and the point at which carrier modulation occurs. Such a pattern corresponds essentially to the pattern given in Figure 27A. It does not indicate a defect or improper operation.

Figure 28B gives the type of pattern obtained where an improperly operated Class C, RF amplifier is used. Such a pattern may be caused by regeneration, improper neutralization or excessive bias.

The pattern shown in Figure 28C may be caused by insufficient RF grid drive to a modulated amplifier or a weak amplifier tube. Saturation is reached on the modulated peaks, resulting in the flattened appearance.

Miscellaneous Waveform Measurements: In this category, we can place such waveform investigations as studies of noise and vibration, sub-sonic and super-sonic applications and hundreds of others. Each of these fields is highly specialized and it is obviously impossible to cover them here. We again refer you to the bibliography for further reading in this field.

AC Voltage Measurements: Because of its peculiar characteristics, the oscilloscope is particularly suited to the measurement of AC voltages. With the advent of television, it has become imperative that such measurements be made accurately without respect to wave shape, so that the conventional RMS reading AC voltmeter is no longer adequate. Most television service bulletins specify peak-to-peak voltages which appear at various points of the circuit. Other applications for such measurements are becoming more common every day.

The OM-3 can be used to accurately measure and display these voltages. It can be calibrated by any one of many methods for this purpose.

When using the oscilloscope for AC voltage measurement, it is sometimes helpful to use the horizontal input setting for the horizontal selector switch. This produces a vertical line which can be focused and centered exactly for most accurate readings.

The following relationships exist between sine wave AC voltages:

RMS x 1.414 = Peak Voltage
RMS x 2.828 = Peak-to-Peak Voltage
Peak Voltage x 0.707 = RMS Voltage
Peak-to-Peak Voltage x 0.3535 = RMS Voltage

AC Current Measurements: To measure AC currents, the unknown current must be passed through a resistor of known value. The voltage drop across this resistor is measured as described above. From Ohm's Law, $I = \frac{E}{R}$ the current can be calculated. It is important that the resistor be non-reactive at the frequency involved. It should also be relatively small with respect to the resistance of the load.

Frequency Measurements: Frequency measurements can be made with an accuracy limited only by the reference frequency source available. In most cases, this can be the 60 cycle line frequency which is usually controlled very closely. The unknown frequency is applied to the vertical input and the reference frequency to the horizontal input. The internal sweep generator is not used. The resultant pattern may take on any one of a number of shapes. Typical patterns are shown below.

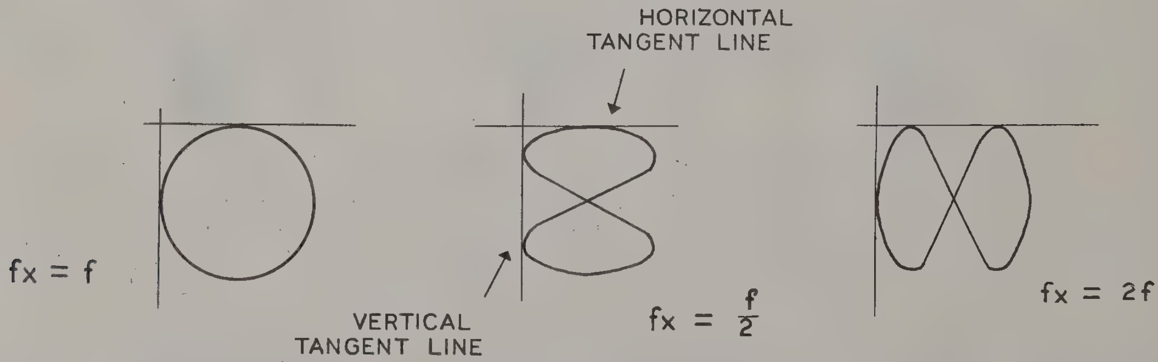


Figure 29

The frequency ratio can be calculated from the formula, $f_x = \frac{Th \times f}{Tv}$ where f_x is the unknown frequency; Th is the number of loops which touch the horizontal tangent line; Tv is the number of loops which touch the vertical tangent line.

When using Lissajous figures as these curves represent, it is good practice to have the figure rotating slowly rather than stationary. This eliminates the possibility of an error in counting the tangent points. If the pattern is stationary, a double image may be formed. In such cases, the end of the trace should be counted as one-half a tangent point rather than a full point. This condition may occur when neither frequency can be varied.

Phase Measurements: It is sometimes necessary to determine the phase relationship between two AC voltages of the same frequency. This can be accomplished quite easily by applying one of the voltages to the horizontal input and the other voltage to the vertical input. The phase relationship can be estimated from the figures below.

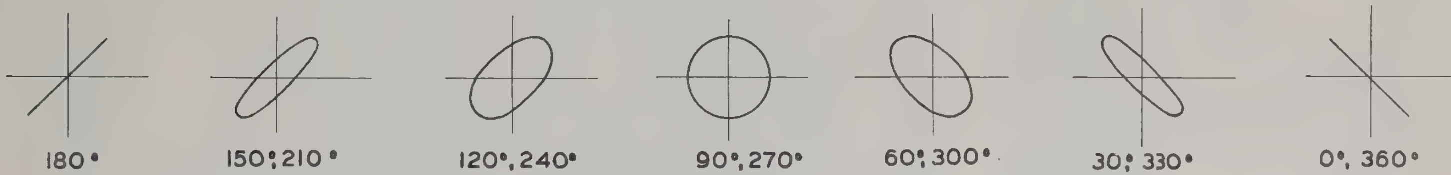


Figure 30

To calculate the phase relationship, use the following formula: $\sin \theta = \frac{A}{B}$

The distance A is measured from the X axis to the intercept point of the trace and the Y axis. The distance B represents the height of the pattern above the X axis. The axis of the ellipse must pass through the point O.

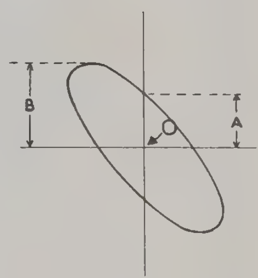


Figure 31

WARRANTY

Heath Company warrants that for a period of three months from the date of shipment, all Heathkit parts shall be free of defects in materials and workmanship under normal use and service and that in fulfillment of any breach of such warranty, Heath Company shall replace such defective parts upon the return of the same to its factory. The foregoing warranty shall apply only to the original buyer, and is and shall be in lieu of all other warranties, whether express or implied and of all other obligations or liabilities on the part of Heath Company and in no event shall Heath Company be liable for any anticipated profits, consequential damages, loss of time or other losses incurred by the buyer in connection with the purchase, assembly or operation of Heathkits or components thereof. No replacement shall be made of parts damaged by the buyer in the course of handling or assembling Heathkit equipment.

NOTE: The foregoing warranty is completely void and we will not replace, repair or service instruments or parts thereof in which acid core solder or paste fluxes have been used.

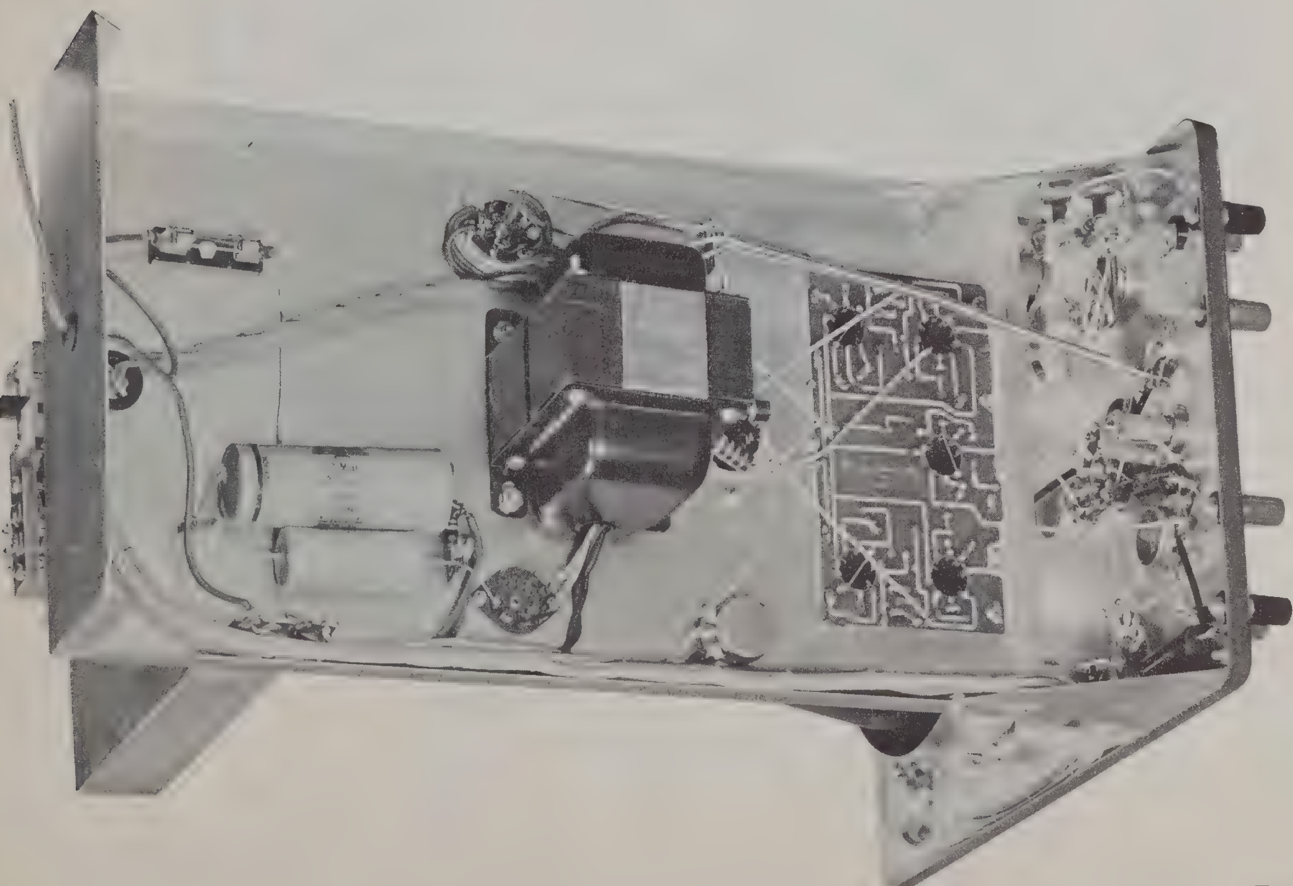
HEATH COMPANY

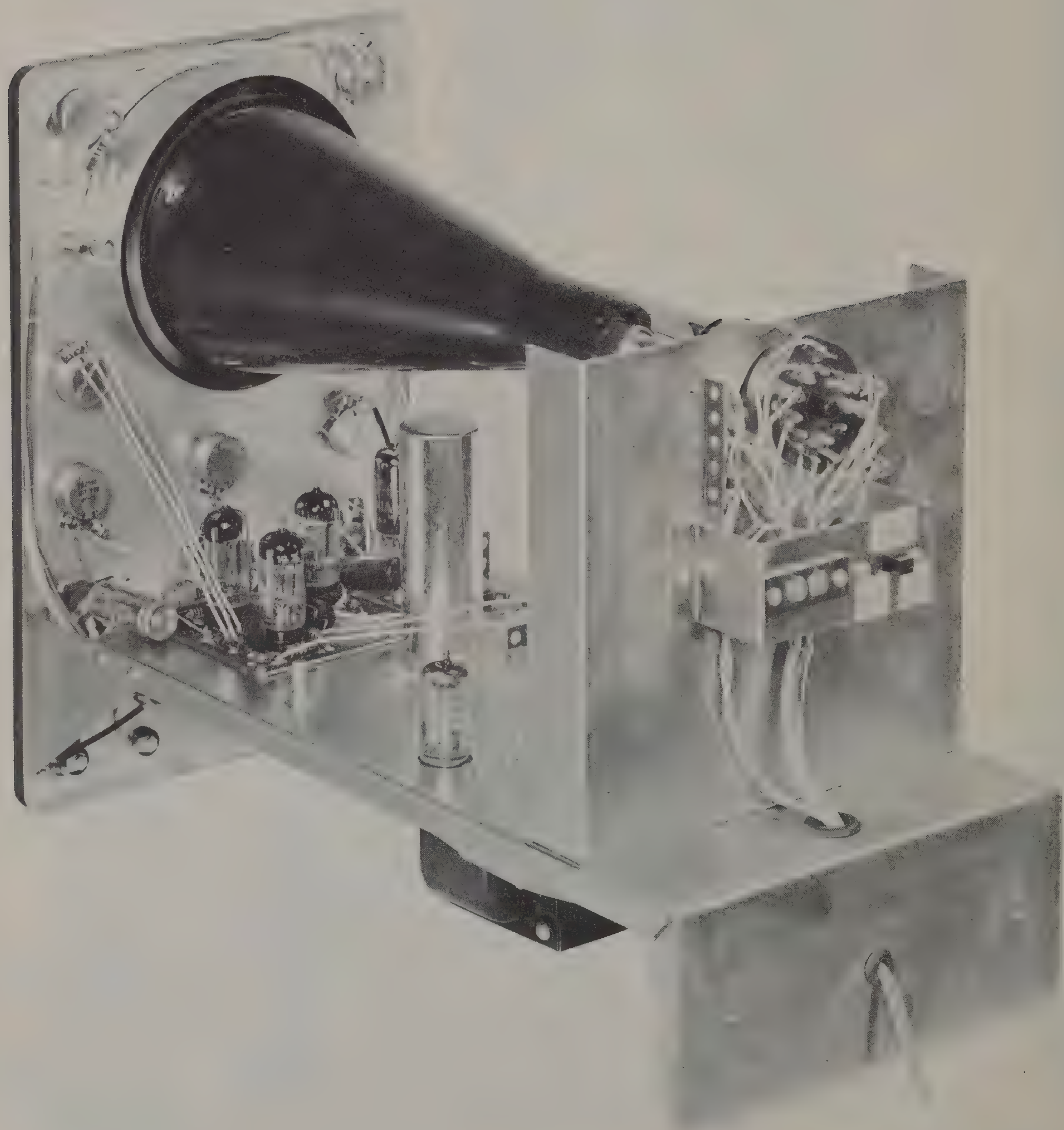
PART No.	PARTS Per Kit	DESCRIPTION
Resistors OK		
1-3	1	100 Ω
1-9	2	1 KΩ
1-10	1	1.2 KΩ
1-14	1	3.3 KΩ
1-20	4	10 KΩ
1-22	1	22 KΩ
1-88	1	36 KΩ
1-25	3	47 KΩ
1-26	3	100 KΩ
1-27	1	150 KΩ
1-29	1	220 KΩ
1-87	1	330 KΩ
1-33	3	470 KΩ
1-35	5	1 megohm
1-37	2	2.2 megohm
1-40	2	10 megohm
1-42	1	270 Ω
1-44	3	2.2 KΩ
1-46	1	3.9 KΩ
1-84	1	62 Ω
1-7A	2	47 KΩ 1 watt
1-33A	1	680 KΩ 1 watt
1-2B	1	4.7 KΩ 2 watt
1-3B	1	10 KΩ 2 watt
1-4B	3	15 KΩ 2 watt
1-10B	1	47 KΩ 2 watt
2-129	1	3.3 megohm precision
Capacitors OK		
20-1	1	47 μμf mica
20-43	1	390 μμf mica
21-5	2	20 μμf disc
21-9	1	100 μμf disc
21-14	2	.001 μfd disc
21-16	1	.01 μfd disc
21-27	2	.005 μfd disc
21-31	3	.02 μfd disc
21-35	1	.005 μfd 1.6 kv disc
21-45	1	.0025 μfd disc
23-10	1	.05 μfd 600 volt tubular
23-28	2	0.1 μfd 200 volt tubular
23-30	1	0.2 μfd 1.2 kv tubular
23-53	3	0.1 μfd 400 volt tubular
23-62	1	0.1 μfd 1.6 kv tubular
25-19	2	20 μfd 150 volt electrolytic
25-32	1	40-20-20 μfd/450 volt and 50 μfd/300 volt electrolytic
31-12	1	dual 5-20 μμf and 100-300 μμf trimmer

PART No.	PARTS Per Kit	DESCRIPTION
Controls-Switches		
10-8	1	10 KΩ control
10-10	1	20 KΩ control
10-11	2	50 KΩ control
10-66	1	500 KΩ control
10-17	2	1 megohm control
10-45	2	7500 KΩ control
19-25	1	50 KΩ control/switch
60-2	1	DPDT slide switch
63-47	2	3 pos. rotary switch
63-83	1	6 pos. rotary switch
Coils-Transformer OK		
45-26	2	33 μh peaking coil
45-22	1	400 μh peaking coil
54-55	1	Power transformer
Tubes-Pilot Lamp-Fuse OK		
411-1A	1	5BP1 cathode ray tube
411-25	2	12AU7 tube
411-26	1	12AX7 tube
411-64	1	6X4 tube
411-65	1	1V2 tube
411-73	1	12BH7 tube
411-98	1	6BA8 tube
412-1	1	#47 pilot lamp
421-1	1	1 1/2 A. fuse
Wire-Sleeving-Cable Assembly OK		
89-1	1	Line cord
100-52	1	Cable assembly
340-2	1	length Bare wire
344-1	1	length Hookup wire
346-1	1	length Sleeving
Sheet Metal Parts-Circuit Board OK		
85-13F182	1	Circuit board
90-34	1	Cabinet
200-M114	1	Chassis
203-68F181	1	Panel
204-M37R	1	Panel bracket, right
204-M68	2	Angle bracket
204-M76L	1	Panel bracket, left
204-M80	1	CRT support bracket
204-M83	1	Direct input bracket
207-M1	2	CRT clamp
210-M1	1	Panel ring assembly
211-4	1	Handle

PART No.	PARTS Per Kit	DESCRIPTION
Sockets-Binding Posts-Terminal Strip-Fuse Clip-Knobs OK		
100-M16B	2	Binding post cap, black
100-M16R	4	Binding post cap, red
422-1	1	Fuse clip
427-2	6	Binding post base
431-2	2	2-lug terminal strip
431-3	2	3-lug terminal strip
431-5	1	4-lug terminal strip
431-6	1	2-screw terminal strip
431-14	1	2-lug terminal strip
431-15	1	1-lug terminal strip
434-15	1	7-pin socket
434-16	1	9-pin wafer socket
434-22	1	Pilot lamp socket
434-46	5	9-pin socket
434-48	1	11-pin CRT socket
462-18	4	Knob, narrow skirt
462-19	8	Knob, skirt indexed
Hardware-Insulators OK		
73-1	3	3/8" grommet
73-2	1	3/4" grommet
73-5	1	Rubber cushion strip
75-17	12	Nylon insulators
206-30	1	Spirashield
250-2	10	3-48 screw

PART No.	PARTS Per Kit	DESCRIPTION
Hardware-Insulators (cont'd.)		
250-8	5	#6 sheet metal screw
250-9	24	6-32 x 3/8" screw
250-13	2	6-32 x 1" screw
250-17	4	8-32 screw
250-83	2	#10 x 1/2" sheet metal screw
250-56	4	6-32 binder head screw
252-1	10	3-48 nut
252-3	36	6-32 nut
252-4	4	8-32 nut
252-7	13	Control nut
253-10	13	Control flat washer
254-1	29	#6 lockwasher
254-2	4	#8 lockwasher
254-4	7	Control lockwasher
254-7	6	#3 lockwasher
259-1	9	#6 solder lug
259-10	6	Control solder lug
261-1	4	Rubber feet
Miscellaneous OK		
390-16	1	Label set
414-4	1	Grid screen
481-1	1	Capacitor mounting wafer
595-185	1	Manual





HELPFUL KIT BUILDING INFORMATION

Before attempting actual kit construction read the construction manual through thoroughly to familiarize yourself with the general procedure. Note the relative location of pictorials and pictorial inserts in respect to the progress of the assembly procedure outlined.

This information is offered primarily for the convenience of novice kit builders and will be of definite assistance to those lacking thorough knowledge of good construction practices. Even the advanced electronics enthusiast may benefit by a brief review of this material before proceeding with kit construction. In the majority of cases, failure to observe basic instruction fundamentals is responsible for inability to obtain desired level of performance.

RECOMMENDED TOOLS

The successful construction of Heathkits does not require the use of specialized equipment and only basic tools are required. A good quality electric soldering iron is essential. The preferred size would be a 100 watt iron with a small tip. The use of long nose pliers and diagonal or side cutting pliers is recommended. A small screw driver will prove adequate and several additional assorted screw drivers will be helpful. Be sure to obtain a good supply of rosin core type radio solder. Never use separate fluxes, paste or acid solder in electronic work.

ASSEMBLY

In the actual mechanical assembly of components to the chassis and panel, it is important that the procedure shown in the manual be carefully followed. Make sure that tube sockets are properly mounted in respect to keyway or pin numbering location. The same applies to transformer mountings so that the correct transformer color coded wires will be available at the proper chassis opening.

Make it a standard practice to use lock washers under all 6-32 and 8-32 nuts. The only exception being in the use of solder lugs—the necessary locking feature is already incorporated in the design of the solder lugs. A control lock washer should always be used between the control and the chassis to prevent undesirable rotation in the panel. To improve instrument appearance and to prevent possible panel marring use a control flat nickel washer under each control nut.

When installing binding posts that require the use of fiber insulating washers, it is good practice to slip the shoulder washer over the binding post mounting stud before installing the mounting stud in the panel hole provided. Next, install a flat fiber washer and a solder lug under the mounting nut. Be sure that the shoulder washer is properly centered in the panel to prevent possible shorting of the binding post.

WIRING

When following wiring procedure make the leads as short and direct as possible. In filament wiring requiring the use of a twisted pair of wires allow sufficient slack in the wiring that will permit the twisted pair to be pushed against the chassis as closely as possible thereby affording relative isolation from adjacent parts and wiring.

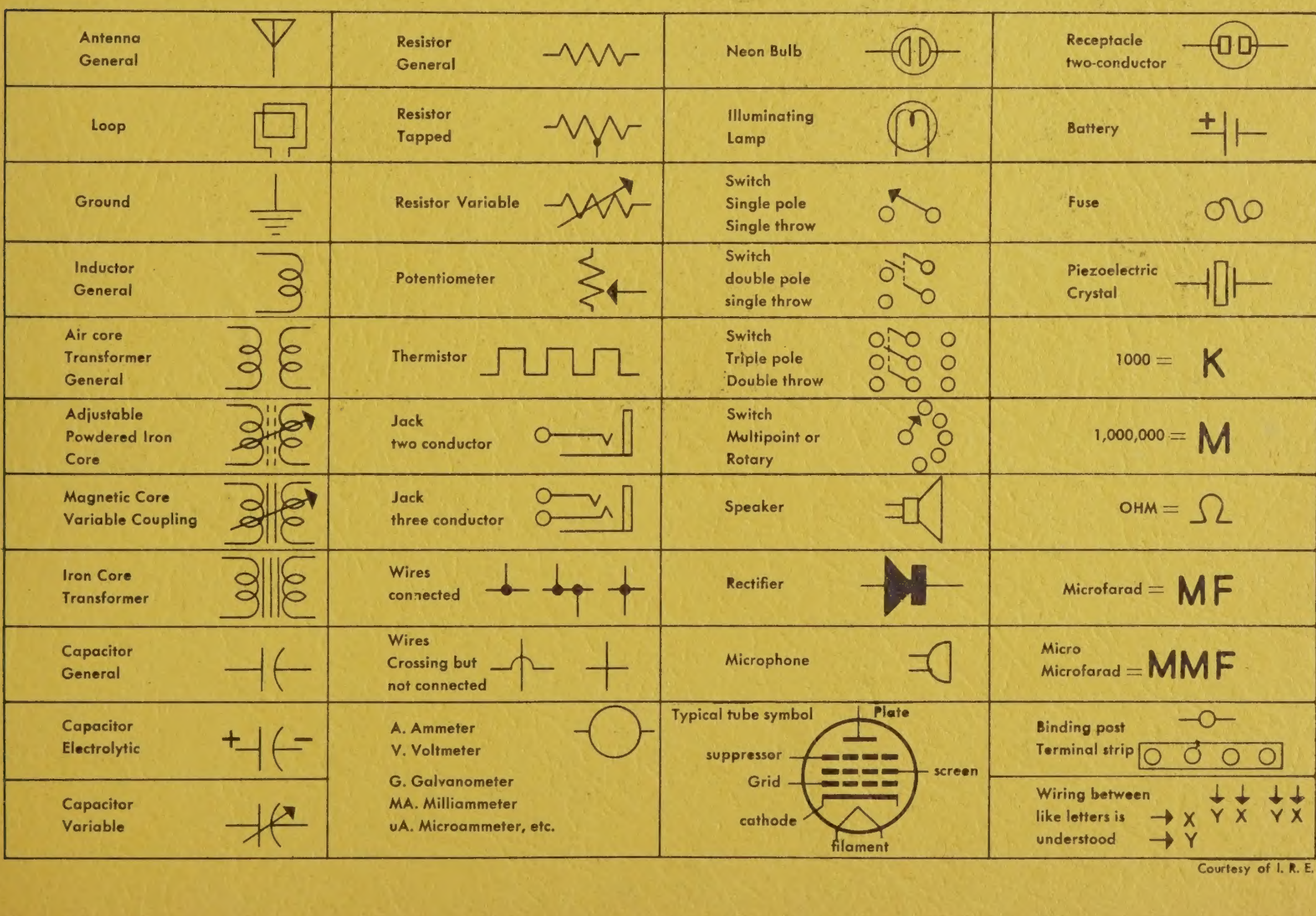
When removing insulation from the end of hookup wire, it is seldom necessary to expose more than a quarter inch of the wire. Excessive insulation removal may cause a short circuit condition in respect to nearby wiring or terminals. In some instances, transformer leads of solid copper will have a brown baked enamel coating. After the transformer leads have been trimmed to a suitable length, it is necessary to scrape the enamel coating in order to expose the bright copper wire before making a terminal or soldered connection.

In mounting parts such as resistors or condensers, trim off all excess lead lengths so that the parts may be installed in a direct point-to-point manner. When necessary use spaghetti or insulated sleeving over exposed wires that might short to nearby wiring.

It is urgently recommended that the wiring dress and parts layout as shown in the construction manual be faithfully followed. In every instance, the desirability of this arrangement was carefully determined through the construction of a series of laboratory models.

SOLDERING

Much of the performance of the kit instrument, particularly in respect to accuracy and stability, depends upon the degree of workmanship used in making soldered connections. Proper soldered connections are not at all difficult to make but it would be advisable to observe a few precautions. First of all before a connection is to be soldered, the connection itself should be clean and mechanically strong. Do not depend on solder alone to hold a connection together. The tip of the soldering iron should be bright, clean and free of excess solder. Use enough heat to thoroughly flow the solder smoothly into the joint. Avoid excessive use of solder and do not allow a flux flooding condition to occur which could conceivably cause a leakage path between adjacent terminals on switch assemblies and tube sockets. This is particularly important in instruments such as the VTVM, oscilloscope and generator kits. Excessive heat will also burn or damage the insulating material used in the manufacture of switch assemblies. Be sure to use only good quality rosin core radio type solder.



Courtesy of I. R. E.

HEATH COMPANY

a subsidiary of DAYSTROM

THE WORLD'S FINEST ELECTRONIC EQUIPMENT IN KIT FORM

BENTON HARBOR, MICHIGAN

Litho in U.S.A.